Regional Distinctiveness of Earthen Structures: Construction Techniques and Conservation Approaches

A Comparison of *Mudwall/Cob* Buildings in Perthshire – Scotland and Normandy – France

Normandy, France

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ABSTRACT

Earth is the most basic construction material, indigenous to many parts of the world and interestingly, regionally diverse and distinct. Over the centuries, lack of understanding made its use in building obsolete. Fortunately, earth buildings, in the current, modern times have begun being recognised for their durability and sustainability.

In conserving the earth building tradition various methods are being adopted. While most efforts are being directed towards material understanding, extent of intervention and technical repairs, there is little insight into traditional habits that naturally conserved these buildings. Such aspects imbibe in conservation today, can make the practice better and simpler.

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1. <u>INTRODUCTION</u>

"A mud building is a defence"

…are the inscriptions – in Latin – over the main door of the Horn Farmhouse and Steading, a Category B listed building in Errol, Perthshire, Scotland.[35]

Figure 2 (a) (b) (c): Horn Farm House, Perthshire – Scotland

This mud building dated to the late 18th Century[36] (with additions in 1820) is a two storey residence, occupied till about 1970; it has received little maintenance and repairs since then, continues to stand tall even today![37] As per the Clay Buildings Rapid Survey conducted by Tom Morton and Heather Winship for the Tay Landscape (TLP) area, published in September 2012, the upper storey is of *unusual high quality*; however, a section of the North wall suffered a *collapse* and the West gable faces a similar risk; the roof and interiors are stated to be in a *relatively sound condition*.[38]

Why is it that some part of the clay building is in a complete healthy state while another part of it suffered major damage?

On a grander scale, regional studies like the above mentioned, those conducted by Parc Naturel Régional des Marais du Cotentin et du Bessin (PNRMCB) in Normandy – France, and on a geographically wider scale, those by larger organisations like CRAterre (International Centre for Earthen Architecture based in France) have together compiled large amounts of data on surviving earth buildings. Some structures have even been documented, analysed and even treated. CRAterre estimates that two-third of the world's population still lives in mud houses,[39] and in addition, there exist granaries, animal sheds and palaces built of mud. These studies, especially those including archaeological findings, have also brought to light that several clay buildings have been lost but lack of records makes it hard to estimate this number. "What survives of clay buildings in Scotland is not representative of what was once there," this statement made at Clayfest 2015 (Scotland), an annual conference organised by Earth Buildings UK and Ireland (EBUKI), gives us a simple idea; this estimation could hold true for many parts of the world! **What is it that has led to the loss of some mud buildings while others continue to be inhabited and even celebrated?**

This study will address such questions concerning the unfired-clay heritage through its wider aims and purposefully selected regions, as have been explained below.

Titled '*Regional Distinctiveness of Clay Structures: Construction Techniques and Conservation Approaches, A Comparison of Mudwall/Cob Buildings in Perthshire – Scotland and Normandy – France*, this study **aims** to:

- understand the richness, nature and treatment of earthen structures
- debate on current and plausible conservation approaches
- explore conservation beyond technical solutions

As the title speaks, this study concerns (unfired) clay constructions across the globe but **focus**es on the selected construction technique of Mudwall/Cob, and the regions in and around the village of Errol in Perthshire – Scotland and the Parc Naturel Régional des Marais du Cotentin et du Bessin (PNRMCB) in Normandy – France. These have been purposefully selected for comparison owing to the significance of its clay heritage and to bring out, in greater detail, the regional distinctiveness in clay constructions.

However, it must be noted that the selected regions are not a representation of clay structures across the globe; clay structures, in their construction and conservation, are very diverse. What may hold true for one clay building may not hold true for the other standing next to it!

2. RESEARCH METHODOLOGY

2.1 Sources and Methods

This report is a result of desk-based and field research.

Various books and journals in relation to earthen constructions have been published. Documents of particular interest to this study were those published by the Tay Landscape Partnership scheme, a broad-ranging social initiative in the Perthshire region and those by the PNRMCB; all referred publications are listed in the Bibliography section of this document.

This project notified me of a conference themed around the culture of earth buildings. An annual session organised by Earth Buildings UK's (now Earth Building UK & Ireland), 'Clayfest 2015' was held in Errol, Perthshire – the very region of interest to my project. This gathering gave me the opportunity to visit various earth structures in the village, interact with villagers, professionals and laymen connected with mud buildings in various parts of the world. The information and insight gathered added to my knowledge and broadened my perspective of clay structures.

While researching on this project I took the opportunity to visit Normandy, where I not only explored the mud heritage of the region but also had the fortune of being hosted by a Cob Builder in an 18th Century cob house and was guided on conducting repairs on it as well!

Further hands-on experience came on receiving a fellowship to attend workshops in natural building, and clay and lime plastering in Prezlomka – Poland. This was very beneficial to my understanding of soil found on site, soil testing, foundations, wall compression and stabilisation, damp-proofing, etc.

In all, I not only researched from books and journals, but learnt hands-on and experienced cob and '*cobbing*'!!

2.2 Challenges and Limitations

Below are some challenges and limitations this study posed

- Difficulty in recognising and accessing buildings

Many clay structures are disguised by stone or brick cladding, and modern finishes (cladding being typical of Errol – Scotland), which makes them difficult to be recognised and thus considered for purpose of study.

Besides, most buildings are privately owned and in use, which restricts access.

- Foreign Language – French

My limited ability in the French language posed difficulties in collecting information about France and its clay structures.

I experienced difficulties in communicating with locals on my visit to survey the clay structures in France, and most studies concerning this region were published in French.

Moreover, many documents were only available as hard copies and it took a great deal of time and effort to manually type, sometimes entire publications, to get them translated through computer software.

- <u>Limited records and documentation</u>

Studies on the regions of interest to this study are limited and the need for further investigation has been expressed in both regions.

Studies conducted within the village of Errol is Scotland are limited to short surveys and reports based on identified clay buildings.

Extensive documentation has been carried out in the PNRMCB in France; however, these studies are mainly restricted to farm buildings.

In all, it is rather difficult to delve accurate information about the clay building tradition as many of these buildings pre-date recorded history, and building with clay was so commonly practiced for at one time that the need to record this method was not even considered. Studies have to rely on salvaged documentation and evidence, which often accumulate as pieces of partial information, thus leaving much to the imagination and inferences that experts and others may have to resort to.

3. SCOPE AND DIVERSITY OF CLAY AND CLAY BUILDINGS

Clay is the most basic construction material, indigenous to many parts of the world and interestingly, regionally diverse and distinct.[40] From defence walls like the Great Wall of China, to individual dwelling and entire settlements like those in South America, farm buildings like granaries and pigeon houses in France and ancient tombs like Maeshowe in Scotland – the list is vast and varied.

Unfortunately, over the centuries, various other building materials came to be preferred and the art of clay building reached redundancy; existing clay buildings too received little attention putting much our earth structures at risk.

Despite it all, a lot of our clay heritage survives… some buildings are centuries old, in perfect shape and continue to retain their original use, like the houses in Devon in South-East England. It is because of simple and minimalist maintenance through the years that the 21st century has inherited such buildings.

Fortunately, mud as building material has, in 21st century begun receiving its due recognition as a durable and sustainable material, and attempts are being made to conserve traditional buildings as well as build new ones. For example, the 18th Century Cottown Schoolhouse in Perthshire – Scotland is being conserved (refer case study in Appendix), and a cob house, Mud and Wood House was built in 2011 in Sligo – Ireland.

Figure 2: 18th Century Cottown Schoolhouse, Perthshire – Scotland

Figure 3: 21st Century Mud and Wood House, Sligo – Ireland

Efforts and enthusiasm towards its survival and revival of the clay tradition are still in its formative stages… While much has been done, much needs to be done as well!

3.1 Why Choose Clay?

Durable and sustainable, earth buildings also carry **qualities** of soundproofing, and thermal and moisture regulation. In Scotland, puddled clay i.e. a slurry of relatively untempered clay that retains its wet state on application, is widely used as a waterproofing agent.[41] In the Carse of Gowrie, Perthshire - Scotland, for example, clay was mixed with straw and used in upper floors of buildings for its deafening quality;[42] it was also a preferred material for mortars, especially in foundations for its resistance to damp.[43]

Built with soil and resources from the very ground and surrounding the structure is built on, constructing with earth **eliminates costs** incurred on buying raw materials and transporting them to the site.

Further, as traditionally practised, earth houses were usually built by their very owners with labour support from the community they lived in. These structures are **fairly simple in their method of construction and tools employed** with even children being able to participate in the building process. Cob houses especially, were usually built by farmers as a farming job and using farming tools.

As a community activity, building with earth gathered people together: families, neighbours, men, women and children, which strengthens social network. Building one’s own home also helps one connect better with the space they live and places in them the want to provide regular care for that space. It also keeps one connected with the natural rhythmic cycles like that of seasons for building, which is between spring and autumn.[44] Thus, in earthen houses lies the embodied energy of **human connection**.

Earth is a **flexible** building material that can be easily moulded; as traditionally was, it was built with no strict, pre-defined plan under the supervision of an ‘expert,’ instead it took its shape and form as those building it decided on what was best as they progressed with the construction. This created buildings that blended with the underlying geology and environmental surroundings of the structure (Figure 4).

Figure 4: A cob building built in alignment with the edge of the road;
Colombières, PNRMCB, Normandy – France

Earth buildings have proved to be **holistic and healthy** too! Built of natural material, they are non-toxic, and are known to provide a calming effect and increase productivity in those who live and or work in them.[45] The wavy lines and curves building, for instance, which building with earth results in relate and sink with the fluid, creative nature of humans and human minds – contrary to the rigid, straight lines and neat boxes of modern constructions.

Figure 5: Wavy lines and curves creating fluidity in the shape and form of earth buildings

Last but not the least, earth as a building material is **reusable and renewable**. Many times, earth for constructing new buildings was sourced from redundant structures. When a building perishes, earth from ruined structure returns to the very ground it came from, and resting back in its natural surroundings.

3.2 Diversity in Clay Constructions

Traditional clay constructions were built with materials available in the surroundings, by the people of the land and for the people of the land. Their constructions were representative of their identity, culture, language and location. Their understanding of their topography, vegetation, climatic cycles, seasonal changes, etc. coupled with their beliefs, traditions and dialects reflected in their construction materials, techniques, the direction in which they aligned their homes, the appellations they used to describe them, etc.

Figure 6: A World Heritage Site, Fujian Tulou – China
is built in keeping with the landscape as well as the principles of Feng Shui

Through the centuries, the sum of such clay structures came to be associated with whole settlements, construction techniques and terminologies, and has amassed as a vast and valuable heritage with a worldwide presence.

3.2.i Regional distribution

Every inhabited continent in the world is witness to the centuries old clay building tradition; below is a map highlighting the regions in which mud buildings exist. Sourced from a 1994 publication (Houben, *Earth Construction: A Comprehensive Guide*), it may be considered outdated but provides a rough idea.

Figure 7: Map showing distribution of mud buildings in the world

For understanding of associations between regions with a clay heritage and the construction techniques they associate with, following is a map providing a closer look at a single continent: Europe. Published in the 21st Century (project *TERRA INCOGNITA – Conservation of European Earthen Architecture,* 2009 – 2011), this map is updated – but not accurate.

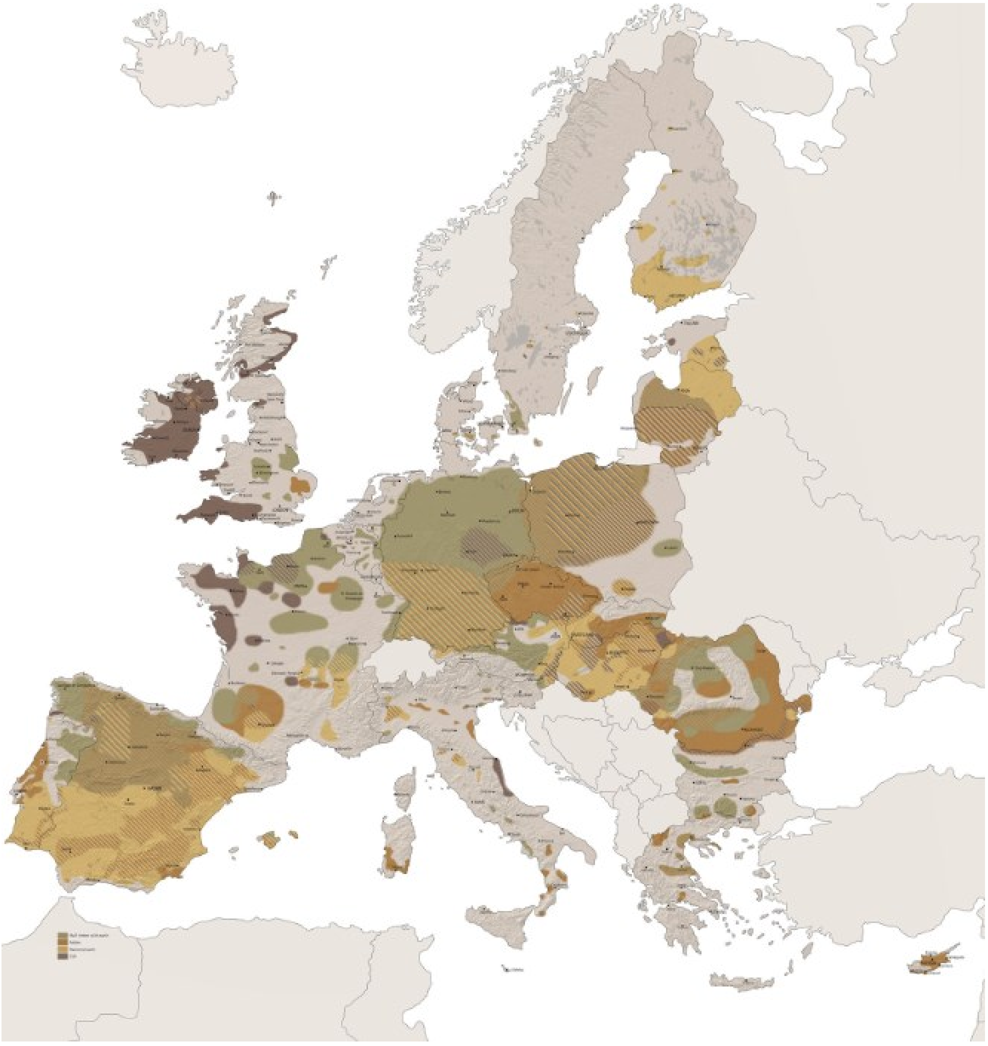


Figure 8: Map showing distribution of earth buildings and construction techniques in Europe

The above map constitutes the regions of Scotland and France (North-East), and the construction techniques, '*Mudwall*'/'*Cob*' (darkest highlights), the association of both are selected for purpose of this study.

3.2.ii Terminology and constructions techniques

Broad classifications can be made based on regions, techniques and terminologies associated with the earth building tradition. However, the richness of this heritage lies is in the vast and varied variations that occur regionally.

Stated and explained below are some commonly found clay building techniques. These descriptions mainly constitute traditional techniques; modern constructions tend to use mechanised methods to mix, mould, etc.[46]

photo credit: Charlène Lerey

Figures 9: (a) Traditional, labour-intensive technique (b) Mechanised techniques used in conservation at Ferme du Bas-Quesnay, Saint-André-de-Bohon, PNRMCB (April 27, 2015)

'*__Wattle and Daub__*:'

The core structure constitutes a wooden weave over which clay mixed with straw or other fibre is applied. The kind of wood, weave and fibre may vary regionally. At

Cottown Schoolhouse in Perthshire – Scotland, which is currently undergoing renovation, there is evidence of rope used in the core, wooden knit.

Figures 3: (a) (b) Traditional and recent wattle-and-daub weave

'*<u>Rammed Earth</u>*:'

Wooden frames are used between which earth is rammed by tamping with feet, tools or both.

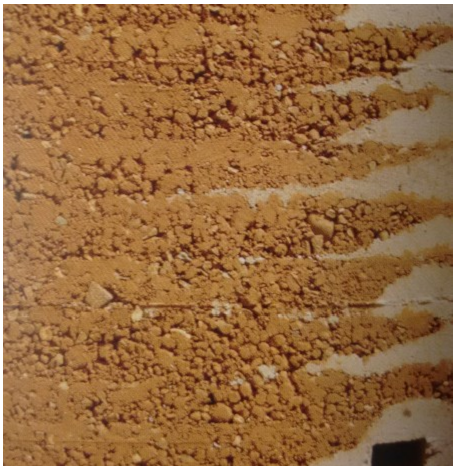


Figure 4: Rammed earth wall

‘*Cob*:’

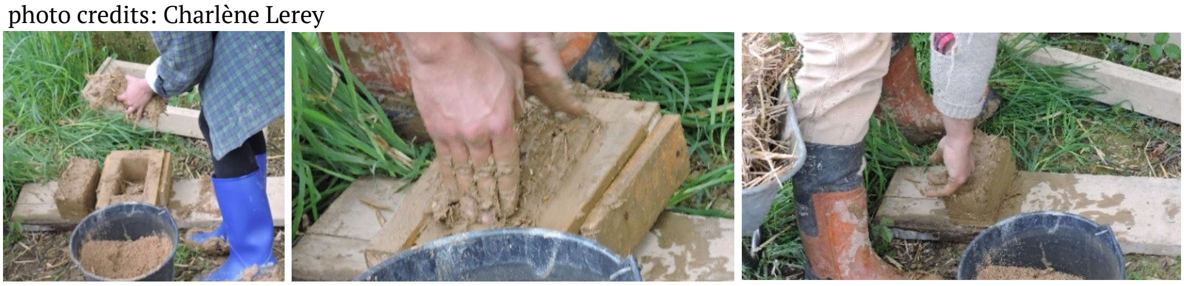
Earth mixed with straw or other fibre is kneaded to a thick consistency and piled in ‘*lifts’* or blocks to erect monolithic walls; formwork may be used[47]. ‘*Lifts*’ refer to horizontal layers of building clay, which are mounted in successive intervals, while erect a Cob wall.

Figures 12: *Mudwall/Cob* (a) soil preparation (b) application, (c) ‘*Lifts*’

‘*Adobe*:’

Sun-dried earth blocks made by thickly-kneaded-clay shaped by hand, wooden or metal moulds are placed together using a mortar. The clay may be mixed with straw.

photo credits: Charlène Lerey



Figures 13: (a) (b) (c) Brick making

In addition to these, there exist an array of construction techniques specific to smaller regions; linked with them are a range of vocabularies that have lent themselves to regional languages and dialects, these include words that may or may not bear obvious connections to clay buildings.

The two terms '*Mudwall*' and '*Cob*' specified in the sub-title of this study: 'A Comparison of Construction and Conservation of Buildings...' refers to the technique of piling earth-kneaded-with-fibre in horizontal layers or lumps to erect walls. It is commonly referred to as '*Mudwall*' in Scotland and is commonly called '*Cob*' in France.

Within France, the nomenclature may vary regionally. Cob walls are called '*bigots*' in the Marais de Monts in Vendée – France;[48] '*bourrine*' refers to a cob house with a roof made of reeds; '*bourrinour*' is a builder or repairer of these houses.[49]

In Poland, very interestingly, the word '*kobieta*,' which from the Polish language translates to 'woman' is believed to stem from Polish women's knack for kneading the cob mix and their preference for cob houses, which they believed held the strength and comfort to keep them and their children safe – as opposed to the men who preferred wooden cabins. Both kinds of structures are evident in the village of Przelomka – Poland (As communicated by Jarema Dubiel (Poland), Journalist and social entrepreneur currently involved with 'Earth, Hands and Houses', specialists and educators in natural building).

'*Cob*' also features in the heritage literature of the French community in Belgium, where the term '*tourton*' was traditionally used; this is attributed to the region of Normandy – France [50]

'*Wattle and Daub*' is more commonly known as '*stake and rice*' in Scotland.[51] Other variations include '*stab and rice*,' '*stake and raip*,' '*wattle-work*,' etc.[52]

The practice of ramming earth between wooden formwork to create walls is called '*pisé*' in France, '*taipa*' in Portugal, '*tapia*' in Spanish, the latter two having been originated from '*tabiya*,' an Arabic term.[53][54] Further variations include '*pisé en terre*,' '*taipa de pilão*,' '*tapial,*' etc.[55]

The construction method of using moulded and sun-dried clay blocks is called '*Adobe'* in Spanish terminology.[56] This term is widely used, Scotland too has adopted it as it does not have too many of such buildings and a term of its own for it.[57] This technique is very common in East Anglia and Cambridgeshire – England, where it is commonly called '*clay lump.'*[58]

There is evidence of a slightly different Cob technique in parts of Normandy – France (near Coutances and Brecey) and is called '*gazon*' or '*paton*.' Here, the clay-mix is similar to that of cob. While still wet and limp, the mix is shaped into rectangular or square blocks and rounded by hands before being placed either horizontally or in a fishbone pattern onto the building wall. Sometimes, formwork or shuttering may have been used. The surface was often beaten, which sometimes makes it difficult to distinguish this technique from 'traditional' Cob. This technique is also present in Brittany – France, where it is termed '*Caillibottis*.' (As informed by François Streiff, PNRMCB)

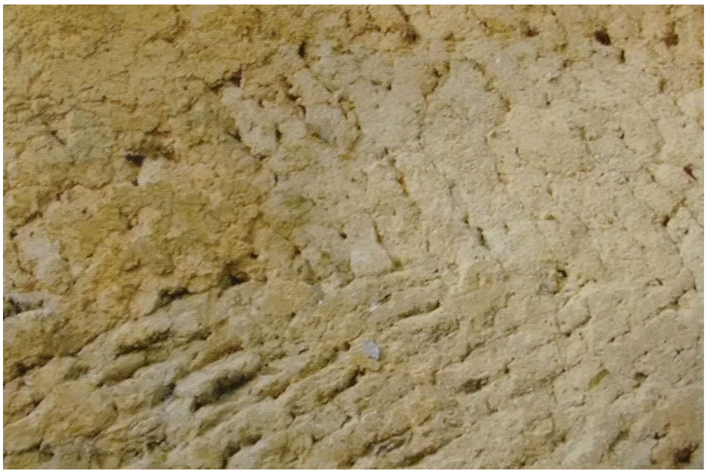


Figure 14: '*gazon*'

A similar technique called 'války,' in which cob-mix is shaped into blocks or rolls and placed directly onto the wall or thrown into a formwork is found in Hungary, Slovakia and the Czech Republic.[59] These blocks are different from those in

Normandy as they are shaped entirely by hand to look like loafs of bread, as pointed out by Lydie Didier, (L'association Asterre – France).

Yet another variation in this Cob technique is discovered in Przełomka – Poland. According to Jarema Dubiil (Earth, Hands and Houses – Poland), this techniques could have involved the vertical placement of kneaded-clay lumps which were paired on building the wall. Lydie Didier (L'association Asterre) associated it with another technique called '*losange*;' however the available photo evidence is not clear and this form of construction is yet to be identified and understood.

Figures 5: (a) (b) Cob in Przełomka – Poland

Clay houses in Scotland are generally referred to as '*Clay Biggins*;' in North England, prominent along the Solway Plain in Cumbria, these are called '*Clay Dubbins*.[60] The former mentioned term also features in Robert Burns', the National Poet of

Scotland's literary works.[61] Both terms are also used in other parts of the United Kingdom as well.[62][63]

Figure 16: '*Clay Dubbin,'* North England

Figure 6: '*Clay Biggin*,' Errol, Perthshire – Scotland

The technical term for tempered earth i.e. a blend of soils of varying particle sizes is '*loam*' but Scottish builders know it as '*mortar*.'[64]

This section is only a brief and is no where close to justifying the scope of traditional, unfired clay constructions across the world. In Scotland alone, in addition to the ones mentioned above, clay has been found in constructions ranging from turf structures: alternating stone and turf, masonry faced turf; natural caves; tunnels; applied to armatures like cabers, straw mat, standards with horizontal ropes; constructions without formwork: unfired clay bricks, stabilised earth blocks; constructions with formwork: clay and bool, claywall; etc.[65] In addition, clay has also been used in floors, furniture, as mortars, deafening, water repellent, plasters and renders, colouring agents, etc.[66]

3.2.iii Building types and purposes

Clay buildings were built to serve a wide variety of purposes; as places for worship; entire villages; residences for kings, mayors, farmers, peasants; sheds and shelters for animals and birds; store-houses; etc. Over time, many retained their use, while others changed function to serve changing needs and demands, some were altered to render them fit for new uses.

Within the PNRMCB alone, where mainly the farm buildings of the region have been documented, there exist a variety of structures built for a variety of purposes. These, mentioned along with their French terms (marked in italics) include, farmhouses (*fermes*): grain farms (*fermes céréalières*) and or animals farms (*fermes herbagères*), which could include one or more of the following: granaries (*granges à grain*), stables (*écuries*), cowsheds and haylofts (*étables*), shelters for pigs and poultry (*toits à porcs et poulaillers*), cart sheds (*charretterie*), wine press and cellars (*pressoir et cellier*), bread ovens (*fours à pain*), dovecotes and pigeon houses (*colombiers et pigeonniers*), enclosure walls and small annexes (*murs de cloture et petites annexes*), single units constituting various farm buildings (*blocs-à-terre*); manor houses (*ferme du manoir*); town houses (*maisons de bourg*); houses of daily-wage-workers (*maisons de journaliers*), etc. The Park also includes buildings that have been reconstructed and rehabilitated.[67]

4. MUDWALL/COB IN PERTHSHIRE AND NORMANDY

The village of **Errol**, Carse of Gowrie, Perthshire – Scotland, and the **Parc Naturel Régional des Marais du Cotentin et du Bessin** (PNRMCB), (Lower) Normandy – France are significant as one of the few regions identified for harbouring a thick density of Mudwall/Cob buildings, most of the surviving structures date to the 18^{th} – 19^{th} Century.

These selected regions, and the evolution, decline and conservation of their structures are best understood in the larger context of the regions they lie in: Errol in the Carse of Gowrie and the PNRMCB in (Lower) Normandy.

4.1 Overview

Errol, Carse of Gowrie, Perthshire, Scotland

Errol is situated in the Carse of Gowrie on the Northern bank of the Tay River in Perthshire, on the East coast of Scotland. The Carse of Gowrie extends from Perthshire to Dundee and Errol lies in the Perthshire region. The village of |Errol is located on a privileged elevation of this low-lying stretch,[68] is its largest village and claims to be the 'capital.'[69]

Figures 18: Maps showing (a) location of Errol in Scotland (b) Carse of Gowrie (c) location of Errol in Carse of Gowrie

The Village of Errol is described to be the centre of Mudwall tradition in Scotland.[70]

In Scotland, three regions show evidence of such Mudwall buildings: Dumfrieshire, Carse of Gowrie and Angus, of which the village of Errol in the Carse of Gowrie displays a sizable concentration.[71] About 40 buildings have already been identified in Errol as compared to the two dilapidating barns in Dumfrieshire and one restored schoolhouse in Angus.[72]

Most of the identified buildings in this region constitute domestic residencies, some are shops on the ground floor with flats on the upper floors. The Mudwall buildings of Errol are characteristic of stone and or brick cladding on external walls.

PNRMCB, (Lower) Normandy, France

The PNRMCB spreads across the departments of Manche and Calvados in (Lower) Normandy, and constitutes itself largely within the Cotentin Peninsula in North-West France. (The Normandy region comprises the divisions of Lower and Upper Normandy.) The Park was created on 14 May 1991 and extends over thousands of hectares of land; it includes plains on the North-East and large expanses of lowlands along the network of water channels that enter the Peninsula from the East.[73]

Figures 19: Maps showing (a) location of PNRMCB in France
(b) location in Lower Normandy (c) PNRMCB

In France, two regions have been recognised for their thick concentrations of this vernacular form of architecture, the other being the Bassin de Rennes in Brittany, also in North-West France.[74] While thousands of buildings have been estimated, documentation is underway and the exact figure is yet to be confirmed.

Most of the buildings documented in the PNRMCB are farm buildings. The region's architectural landscape presents a range of colours owing to its variety of soil types, the traditional buildings bear no plasters and display conspicuous stone plinths and fenestration encasements.

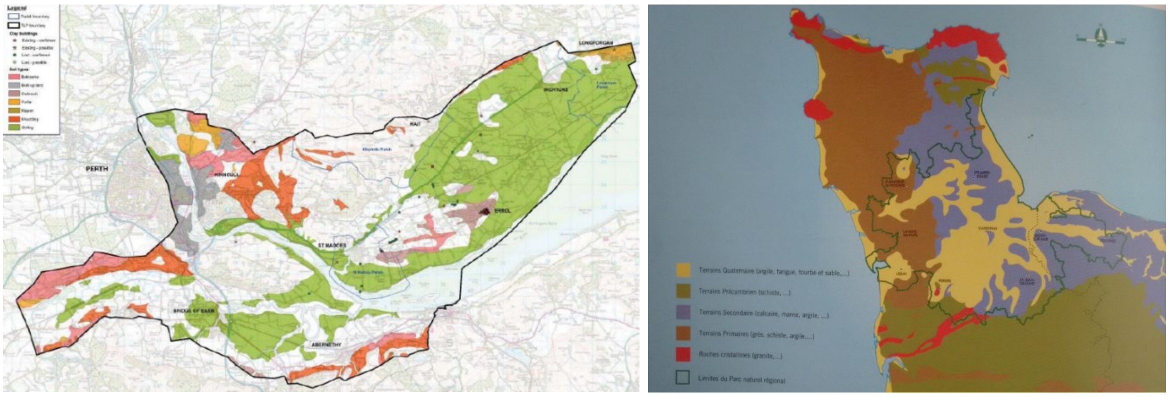
4.2 Reasons for the Presence and Survival of the Distinct Mudwall/Cob Walls

The Mudwall/Cob structures of Errol and the PNRMCB have been recognised for their dense concentration, survival and characteristic features; the reason for their presence can be attributed to their locations, histories, backgrounds, etc, some of which are cited below.

Figures 20: Earth houses in (a) Carse of Gowrie (b) Normandy (April 27, 2015)

- <u>Geology: Loamy soils and stone</u>

Both regions being situated on low low-lying areas along sea coasts, banks of rivers and estuaries, contain a variety of soils rich in clay and alluvial content, which in turn favour Mudwall/Cob constructions.



Figures 71: Maps showing geological distribution of soils/stones in
(a) Errol (b) PNRMCB

In Errol, Mudwall was the main building culture; stone was not naturally available and was introduced with developments in transportation. As it became popular, the clay resource of the land was used to fire bricks. These new materials were used to clad clay walls.

In PNRMCB, soil was largely the building material. Stone was naturally available in some regions, however, in most part of the Park it was either scarce or difficult to extract. La Haye-du-Puits in the North and Saint-Sauveur-le-Vicomte in the East of the marshes were prime for their availability of stone, which was used in plinths; stone for fenestration encasements came from nearby regions outside the Park.

This rich geology of the PNRMCB region has lent its architecture a wide palette of colours ranging from shades of dark reds, ocher yellows, browns and greys.

Figure 8: Soil samples displaying geological richness of the PNRMCB region

- <u>Rainfall and water management:</u>

The loamy soils of the regions are also a result of the rainfall received throughout the year. While water is an essential factor in Mudwall/Cob constructions, it could prove detrimental if it accumulates in large volumes and is left unmanaged around a built structure. The village of Errol is well drained with parts allotted to marshes, wells, etc;[75] in the PNRMCB, efforts have been made to minimize floods and manage water retention in the region.[76] These actions can be attributed to have largely contributed to the survival of the structures of these regions.

- Agriculture:

In both regions, agriculture thrived for a very long time. Agricultural byproducts like straw and thatch was used in construction; straw was mixed with soil to give tensile strength and prepare it for building, thatch was used as roof coverings. Agricultural materials like the tools were used to aid building.

- Inheritance of building skill and local identity:

The available building resource gave rise to a building skill and tradition that the people of the land improvised through the generations and strongly identified with. The tradition of earth building in both the regions have been traced to the pre-history and continued till the second half of the 20th Century.

- Availability of timber

Timber was plenty in both the regions; in addition to providing roof coverings that protected clay walls, it was used in construction as well. The technique of erecting a wooden mesh around which building clay was applied in layers to form thick, strong walls is popular in both regions.

Mudwall/Cob building developed as a direct relation between the inherent features of the land and the people who inhabited it, and has made possible the manifestation of buildings of varied volumes and dimensions and sheer strength and durability.

4.3 Mudwall/Cob

The Mudwall/Cob buildings of Errol and the PNRMCB are observed to include significant variations in techniques as well as appellations.

A certain Mudwall/Cob technique remains dominant in both regions and its basic construction process is described below. This is followed by an explanation on the variations in terminologies and techniques that exist in each of the two regions.

4.3.i Construction of Mudwall/Cob walls

In both regions, the most commonly found building technique is what is referred to as *Mudwall* in Errol and '*Bauge*' in the PNRMCB; the term '*Mudwall*' is employed all over Scotland[77], while in France '*Cob*' is more commonly used[78]. This technique involves the piling of earth-kneaded-with-straw-or-other-fibre in '*lifts*' to raise monolithic walls; [79][80] further features distinguish the *Mudwall/Cob* walls of the two regions. '*Lifts*' refer to horizontal layers of building clay, which are mounted in successive intervals in order to erect walls.

The construction process of this traditional building method is recorded as follows:

- <u>Recognizing, sourcing and blending soils:</u>

Soils are sourced from near and around the construction site.[81][82] In Errol, the exact sources can now not be traced though the construction soil is recognised to be from the region.[83]

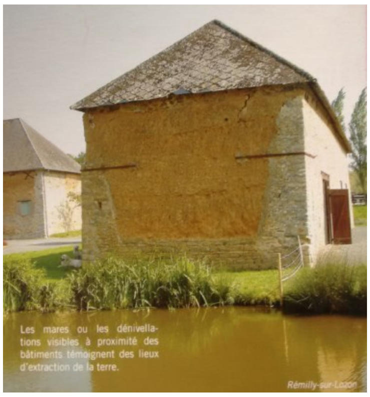


Figure 23: In the PNRMCB, clay sources are more apparent, especially through sharp differences in ground levels and depressions, which now exist as water pools clearly visible near built Cob structures.

The ideal soil for Mudwall/Cob construction is a mix of clay, silt, sand, gravel, etc; the various particle sizes ensures better cohesion in the building clay and ultimate strength of the built structure. This ideal mix is rarely readily found and is worked by sourcing and mixing different soils types from the region.

Figure 24: Different sizes in soil particles

- <u>Preparing soils for construction:</u>

The soil aggregate is then mixed with water and straw or other fibres such as heather, broom, flax, hair, bristle and dung, and kneaded to a thick consistency. The mixing was done by animals or humans stamping and stomping by feet, though hands could also have been used. In modern times, machines are employed.

- <u>Piling or preparing '*lifts*'</u>

The soil prepared with fibre is picked in lumps by hand or forks and placed on a pre-constructed stone plinth to form a horizontal layer / '*lift*.' (Figure 12(c)) The *lift* is then compacted using a wooden bat, which straighten the uneven shape of the *lift*, increases surface area, removes trapped air and tightens cracks that might developed have or could appear on drying; in addition, compacting can also be achieved by walking over the achieved *lift*. The formed *lift* is then left to dry for a few days or weeks, depending on its size, after which it is pared from the sides using a sharp and flat spade. Finally, the *lift* is compacted for further cohesion and tightening and smoothed with a timber float. Consequent *lifts* are built until the desired wall height is achieved.

Figures 9: (a) (b) (c) (d) (e) The Cob building process

4.3.ii Terminologies and techniques

The *Mudwall/Bauge/Cob* walls in Errol and the PNRMCB bear distinct features, characteristic to the own regions. These and other occurring variations are listed below.

<u>Errol, Carse of Gowrie, Perthshire – Scotland</u>

In Errol, Carse of Gowrie, the *Mudwall* technique has been documented to have been employed in three different ways:[84] Various other uses of clay as a construction material are also evident.

- <u>*Mudwall*:</u>

The most common method is to build walls in '*lifts*,' as has been described above. '*Lifts*' in the Carse of Gowrie are about 0.002m – 0.30m in height. These buildings were plastered, the external wall usually receiving a finish of lime harl or wash. The internal walls, especially of lesser important spaces like attics and agricultural buildings were left exposed.

Figures 26: (a) An outbuildings in Errol (b) interior walls left exposed without plaster (June, 2015)

- <u>Masonry-faced *Mudwall*:</u>

Some *Mudwall* buildings were clad on the outside with bricks or stones. This could have been done at a later date either for aesthetic purposes or protecting the structure from weather and wear.

- <u>'*Stake and Rice*':</u>

Globally, this technique is more commonly referred to as '*Wattle and Daub*.' Worked by applying clay-mixed-with-fibre on a wooden woven mesh '*Stake and Rice*' is archaeologically documented to be widely employed in Scotland. However, surviving examples are very few.

Figure 10: *Stake and Rice* at Cottown Schoolhouse, Perthshire – Scotland

PNRMCB, (Lower) Normandy – France

In the PNRMCB, (Lower) Normandy too, Cob is implemented in multiple ways; most structures are identified with the technique called '*Bauge*,' some with '*Torchis*;' variations in the two have also been recorded.[85] Interestingly, the presence of one building that employs the method of '*Pisé*,' has been recorded.[86]

- '*Bauge*':[87]

The common technique of piling the cob-mix in horizontal layers or '*lifts*' to erect walls without the use of formwork. It is commonly referred to as '*Bauge*' in the PNRMCB, but additional local terms exist within the region; these include '*Mur de terre*,' '*Masse*,' '*Massé*,' '*Mur d'argile*,' etc. In the PNRMCB, lift heights vary from 0.60m – 1.20m.

Figure 11: Map of the PNRMCB emphasising local appellations of the '*Bauge*' technique

- *'Torchis':*[88]

The cob-mix is applied onto a wooded weave to form walls. The commonly accepted, world-wide expression for this technique is '*Wattle and Daub*.' A rare example of this technique is noted in the region of Prétot-Sainte-Suzanne.

Figure 12: '*Torchis*,' PNRMCB, Normandy – France

- *'Pisé':*

Soil mixed with gravel and a small quantity of water is compacted within a formwork. This technique is universally familiar with the term 'Rammed Earth.'[89] It is not recorded to be commonly employed in the PNRMCB with only one such edifice having been documented in the region.

4.4 Historical and Architectural Evolution

The culture of Mudwall/Cob building is indigenous to regions of rainfall and loamy soils, which in turn support agriculture. The historical evolution of agriculture, whose by-products are essential for Mudwall/Cob building bears an obvious and direct effect on the presence and evolution of these structures.

The historical evolution of agriculture and Mudwall/cob architecture in Errol and PNRMCB are explained below.

<u>Errol, Carse of Gowrie, Perthshire – Scotland</u>

Archaeological studies concerning Errol, Carse of Gowrie state that clay has been used as a construction material in and around the region through the Roman and Medieval times.[90]

Over the centuries, the region of what is now the Carse of Gowrie was reclaimed and came to be one of the most fertile parts of Scotland.[91] Errol, in particular, was also well drained, and agriculture and Salmon fishing flourished on a commercial scale until the end of the 19th century.[92]

In the 18th – 19th Century, the village constituted only clay houses.[93] Mud was obtained from what was known as the 'Little Muir' though its location can now not be traced and records speak of land proprietors taking clay for repairing their houses.[94] Most of the surviving buildings that have been documented date from this time. Records from this period indicate a rise as well as decline of the clay building tradition.[95] This period coincides with that of improvements in agricultural, and consequent enhancements in building stock and quality, as well as the loss of whole settlements inhabited by farmers, tradesmen, etc.[96]

Clay remained a dominant building material in the Carse of Gowrie for a long time in history.[97] In spite of the introduction of stones and bricks, it is recorded to have continued well into the 20th Century with an old builder in Errol clearly recalling the *Mudwall* technique of '*Stake and Rice*' being practiced even in the 1970s.[98]

PNRMCB, Normandy – France[99]

Archaeological findings in the PNRMCB, Normandy indicate wide use of '*Bauge*' prior to the 16th Century. From the thousands of surviving structures, only a few date to the 16th Century; most belong to the 18th – 19th Century.

Until the late 17th Century, agriculture in the region mainly thrived in divisions of apple plantations in the elevated regions of the Park, and pastures for sheep, cattle, horses, etc. in the low-lying areas. Farmsteads of this time are typical in constituting a series of buildings: the residence and a series of outbuildings like wine presses, cellars, granaries, etc. as well as a vegetable garden. The main residence clearly stood out by the treatment it received: fenestration of rather uniformly distributed and stone encasements; however, as agricultural activities grew, the buildings associated with it also began gaining importance and receiving similar treatment.

In the 18th Century – 19th Century, efforts towards managing floods and water retention in the Park[100] accelerated the new system of farming in which dairy production gained importance and large expanses of land were converted from ploughing fields to grazing fields, which in turn led to growth in economy and population. This created an urgent need for more space to accommodate the demands for farmsteads, both residences and agricultural buildings. The readily available agricultural material combined with the clay resource of the land made building with cob the obvious choice. Farmsteads came to be single units: typically, on the ground floor was one room allocated as a living space and was the only room with a fireplace; other rooms included wine presses, cellars, cowsheds, etc; on the upper floors were granaries and attics; larger farms included shelters for pigs, hens, pigeons, etc. Sometimes, a bread oven was built as well but was set away from the other buildings because of the risk of fire. Also important to the architectural identity were the impoverished dwellings of the daily-wage-workers, which usually were single homesteads, sometimes including a cowshed and cellar.[101] The group of farm buildings housed under one roof was referred to as '*blocs-à-terre*' and the living space, which was the only room with a fire place was called '*pièce à feu.*'

Figures 13: (a) (b) 18th Century, La Maison des Marais with its bread oven,
Marchésieux – PNRMCB (April 27, 2015)

By the end of the 19th Century, the region came to be reputed for its animal farming activities, and agricultural buildings for sheltering livestock gained prominence. On the other hand, granaries and other buildings associated with cereal production came to be obsolete and were converted into bedrooms by increasing their roof heights and linking them with a staircase to the ground floor living space or '*pièce à feu*.'

Figure 14: Bricks used to increase roof heights, Normandy – France

The 19th – 20th Centuries, in both regions, are associated with the rapid growth of population, change in industrial patterns and the wars; consequent introduction of building materials like stone, lime, concrete, etc, which majorly changed the architectural identity of the regions.[102][103]

4.5 Loss and Revival

Developments and commercialisation that began around the 18th Century marked the onset of the decline of the clay building tradition in many regions of the world including Perthshire – Scotland and Normandy – France.

Many common reasons can be sighted for the loss of Mudwall/Cob buildings in Errol and the PNRMCB but the chronology of events and patterns that led to the loss differ in both regions, these are explained below.

4.5.i Reasons for loss

Errol, Carse of Gowrie, Perthshire – Scotland

- Introduction of new materials:

In Errol, Carse of Gowrie, as improvements in transportation and road networks made stone easily accessible and cheaper, building with clay began to be perceived as labour-intensive and expensive.[104] The clay resource of the land then began being utilised to fire bricks and yet another building material became readily available.[105] Further, with the introduction of lime, and especially cement, the clay building tradition became redundant and died out.

- Decline in agriculture:

Along with the possibilities of new building supplies, lack in availability of agricultural materials required for Mudwall constructions was also responsible for the decline of this traditional craft. Straw and thatch, largely employed in Mudwall building became scarce as agriculture decline in the region.

- Spread of fires:

Though clay is fire-resistant, the thatched roofs that traditionally covered the houses are not and buildings suffered loss in case of fire. The region of Errol, Carse of Gowrie suffered higher risks and damages as buildings were in close proximity and fire spread easily leading to the loss of multiple building at a time.

- Industrialisation, migrations and abandonment of buildings:[106]

Errol was once known for its flourishing economy upheld by its numerous farmers, blacksmiths, weavers, etc. They, however, were defeated by competition from large industrial houses, which led to residents moving out in search of jobs, and consequent abandonment and dereliction of whole settlements.

PNRMCB, (Lower) Normandy – France

- Change in agricultural patterns:

Prior to the 18th Century, farmers in Normandy owned small farmlands that laid scattered but may have summed up to large areas of land. However, on establishment of the legalities of '*Remembrement*' land was swapped and farmers were allotted one, large piece of land to the equation of the several smaller ones they had previously owned; this was done in order to facilitate large scale production and compete in world agricultural markets. In the process, however, small land holdings were lost to foreign owners; the large, acquired farmlands often came as a disappointment to farmers who felt a sense of disconnect from their lost, family lands whose ground had been tended and treated for better yield by their ancestors for generations.

- Industrialisation, migrations and abandonment of buildings:

With the 19th Century industrial revolution, farming began to adopt mechanised methods. This reduced the demand for labour work and the youth began moving to cities in search of jobs, which led to the abandonment and decay of many houses.

- Decline in numbers of daily-wage-workers:[107]

The daily-wage-workers who lived in simple, single room houses were often in charge of the maintenance of bigger farmsteads. As they dwindled in numbers, many farm buildings suffered from lack of maintenance leading to decay and loss.

- Introduction of new materials:

In the 19th – 20th Century, the arrival of coal allowed for the manufacturing of bricks,[108] road networks were developed and construction materials like stone, lime and cement took over the construction practice of the region. This period coincided with the coming of Italian migrants, many of whom were construction workers and were quickly recognised, especially for their skill of rendering walls with cement – to look like stonework.[109]

- Destruction from war:[110]

In the 20th Century, the wars caused large scale destructions; rebuilding provided architects the opportunity to implement newly available materials like stone and cement, had a large impact on the architectural landscape of the region.

- <u>Loss of traditional skill and knowledge:</u> In both regions, traditional skills and understanding of clay buildings date way back in time and the technicalities and specifics with regards to its building and repairs have gone unrecorded and are lost in oblivion.

In addition, in both the regions, the number of lost buildings cannot be accurately estimated because of lack of documentation and evidence.

4.5.ii Conservation

Both the regions, Errol in Perthshire – Scotland and the PNRMCB in Normandy – France have been recognised as significant for their Mudwall/Cob constructions and efforts to document, understand and conserve the buildings in these regions are underway.

Four buildings have been listed for protection in each of the two regions. Cottown Schoolhouse in Perthshire is an example.[111] In Normandy, only four Cob building have been listed, all of which are in the PNRMCB.

In the Carse of Gowrie, repairs are being undertaken to damaged parts of buildings identified to be at risk.

Figures 15: (a) (b) Damage and repairs at Horn Farm, Carse of Gowrie, Perthshire – Scotland

The PNRMCB has adopted the implementation of plasters on buildings in order to protect their buildings; reconstruction and rehabilitation are other conservation methods employed.

Figure 16: Plastering and conservation at
Ferme du Bas-Quesnay, Saint-André-de-Bohon, PNRMCB (April 27, 2015)

7. WHY CONSERVE?

Earth has been used as a building material since time immemorial; over the years the craft of earth building developed – and declined. In the 21st Century, the many surviving buildings, settlements and landscapes are attracting attention and demanding care.

In Errol, Carse of Gowrie, Perthshire – Scotland and PNRMCB, Normandy – France, the Mudwall/Cob buildings have been specifically recognised for their voluminous densities and building sizes, resilience in quality and survival, relevance to their localities, and rare and distinct architectural identities.

Earth building, especially the Mudwall of Errol and Cob of the PNRMCB are valuable heritage assets, deserving of protection. Reasons for this include:

- Antiquity, and evidential significance:

Earth was the original building material used by early humans to build their homes as it was abundantly available, and easy to procure and use. Sometimes, these buildings are the only surviving evidences that provide an insight into human life and building cultures that existed before history began to be purposefully recorded.

The Mudwall/Cob buildings of Errol and PNRMCB date from the 16th – 19th Century and are commendable for the quantities and qualities in which they continue to exist; they make for a living landscape that serves as physical evidence and provides a visible understanding of the evolution of human life and practices in the regions.

- <u>Worldwide and local significance:</u>

Earth buildings are a direct result of the land resource, especially the soil of the region they are built on. The worldwide abundance and regional varieties of these resources have resulted in a common tradition of earth buildings that bear vast and distinct variations. The resulting manifestations are significant as a whole – as a global heritage, as well as in their parts – for their local relevance.

In Errol and PNRMCB, it is the land's resource as well as the ability of their inhabitants to understand and use the resources to create architectural expressions that continue to serve their purpose through centuries – that marks the Mudwall/Cob heritage of these regions as exemplary!

- <u>Identity, and social significance:</u>

As with all traditional buildings, the Mudwall/Cob structures and landscapes in both the regions serve as tangible evidences that allow inhabitants to connect with their ancestral roots as well as bind them together in a community that shares a common culture; it thus meets the innate human need of having a conscious understanding of one's inherited pasts and physical surroundings and drawing a sense of identity and belonging from them.

- Financial:

As distinct architectural manifestations, earth buildings contribute to creating unique landscapes, which in turn, in many places, contribute to tourism by generating income and employment. In addition, individual buildings are competitively priced, and old earthen buildings and spaces provide ample scope for adaptation and reuse.

The PNRMCB with its many Cob houses of varied dimensions and patterns, set amidst expanses of grasslands and marshes, and narrow winding streets fringed with blooming dandelions and other blossoms, makes for a picturesque and relaxing holiday destination; its popularity is evident in the several Bed and Breakfast options in the region. With regards to current property prices, in Errol, flats on the High Street (district postcode: PH2), where Mudwall buildings exists, currently range from GBP 80,000 – GBP 120,000, as compared to Perth High Street (district postcode: PH1), where it is GBP 80,000 – GBP 1,00,000 (www.zoopla.co.uk).

- Embodied Energy:

Earth buildings carry in them the embodied energy totaling from agricultural and construction labour. The measure of human resource embedded into traditional Mudwall/Cob constructions is particularly high as it involved the laborious effort of whole communities. As gathered from interactions with the villagers of Errol, this is true of this region as well, where like the rest of Scotland the completion of a building construction is recalled to have ended with festivals and parties expensed by the owner.[112]

- Risk and urgent need of attention:

The tradition of earth building declined with the introduction of new materials, and over time, the skill and understanding of using this naturally available resource was lost. Furthermore, their implementation of modern materials, especially cement, on traditional buildings proved detrimental to the health and life of traditional structures.

Lack of expertise and know-hows of this traditional material has been expressed by both the regions, Errol and the PNRMCB; the effects of modern, inappropriate interventions are also apparent.

- Relevance in modern times:

As living and tangible structures, mud buildings in general, including those in Errol and the PNRMCB are providing physical evidence and a ground for the understanding of the earth building tradition that was once commonplace – but is now lost and in the process of being re-learnt.

Like in many other parts of the world, the buildings in these regions continue to thrive through centuries, which has proved mud to be a durable building material. The abundance and natural availability of mud furthers its capacity as an economic and eco-friendly building material. The survival and revival of this tradition bears the potential of addressing global issues like poverty mitigation and sustainable development.

6. CONSERVATION

The tradition of mud building is an ancient science that has continued through generations. Centuries old structures existed in traditional society as they exist today. However, the science of conservation does not feature – at least boldly in heritage literature, while in the today's society it is a formal practice and involves calculated actions. What is it then that ensured the health and survival of buildings in traditional times and passed the built clay heritage to the current, modern generation?

6.1 'Traditional Conservation' – Did/Does That Exist?

The conservation of traditional times can be read between the layers of traditional building cultures, traditional life practices and beliefs, which subliminally supported conservation, thus making it a way of life rather than a separate and disconnected activity. It is thus little wonder that 'Traditional Conservation' necessitated no formal recognition.

This section aims at exploring tangible and intangible aspects of traditional living that subtly – but heavily – contributed to conservation and more so, prevented and or eliminated the need for deliberate intervention.

6.1.i ‘Preventive Conservation’ or ‘Defensive Conservation’

Traditional buildings were constructed with a vision; they imbibed techniques and structural designs that guarded their long-term survival as well as allowed maximum use of natural and renewable resources, thus ensuring sustainability too. This concept of acting with foresight and thus preventing and or eliminating the need for active and measured future conservation may be termed, in modern times, as ‘Preventive Conservation’ or ‘Defensive Conservation.[113]

Traditional inhabitants in different regions of the world, with their profound understanding of their micro environments and climates effectively used available local land resources to develop distinct clay building techniques, and structural features that protected as well as provided for their buildings for generations.

The surviving clay buildings of Errol, Carse of Gowrie, Perthshire – Scotland and the PNRMCB, (Lower) Normandy – France are a witness the successful use of clay as a building material. Some regional implications and structural features that ensured the durability and sustainability of clay structures in their local environments include:

- Developing clay as a building material:

In recognising earth as a construction material itself, the clay building tradition incorporated clay’s many qualities to its advantage. For example, while it did acknowledge that clay walls might face the danger of water seepage especially in rain prone regions, it also recognised that the walls are capable of naturally drying and thus restoring themselves; by having incorporated further structural features, mainly strong foundations and roofs, earthen buildings have proved to nullify the risks posed by water.

In the Mudwall/Cob technique, erecting walls in *lifts* ensured shrinkage of the soil during construction itself, thus resulting in a built wall that is strengthened and stable.

- <u>Additives in preparation of building material:</u>

In many parts of the world, local produce and other available matter were often added while preparing soils and plasters for construction, in order to improve workability and strength of the building material/building.

In India, eggs and resins from local fruits acted as binders; in some regions of the country lentils were added too.

In preparation of plasters, additives were often added to enhance the material's strength, especially its ability to resist water.

In Poland, in the preparation of lime plaster, bones, eggs, cheese, meat, etc. have been used since ancient times. In the making of clay plasters, cow dung was often used, among others was a liquid substance produced by burning pieces of birch tree barks. (As communicated / demonstrate by Jarema Dubiel; Earth, Hands and Houses)

Figure 17: Preparing a waterproofing additive for plasters from the bark of birch trees – Poland

Oils are particularly common in many traditions as a waterproofing agent. In Africa, vegetal matter was beaten into the render to extract its oils and in Scotland, linseed oil is known to have been added.[114]

- Skilful positioning of the structure and its features:

Clay structures were built away from drains, and gutters were placed away from walls, which reduced the risk of water ingress and dampness in walls.

Errol and the PNRMCB, both being regions dominated by western winds, the facades of many structures were aligned in the South-East direction, thus reducing erosion of walls as well as letting in maximum sunlight into the building.

- Foundation and plinths:

Traditional earth buildings feature three main types of foundations and plinths. One with a bulging base, the second whose walls are wide at the base and taper as they rise, and the third made of stone. These are done to support the weight of the structure as well as to provide resilience against the risk of water seepage from the ground, which is especially high at this, base part where the building is in direct contact with the ground and its accompanying moisture.

The latter two types of plinths are both particularly observed in Errol and the PNRMCB. (Images follow)

Figures 18: Foundations/Plinths (a) Wide base walls, Errol (b) Stone plinths, Normandy

- <u>Wall Thickness:</u>

Clay walls were built to be thick in order to ensure stability and durability. Additionally, external walls were often thicker than internal walls to render them stronger and more resilient to the effects of changing seasons and other environmental factors, external wall directly exposed and subjected to.

- <u>Renders:</u>

Clay and lime renders often covered the external walls of earth buildings and protected them from water penetration and erosion caused by winds. These plasters also share clay's inherent qualities that allow for seasonal cycles of wetting and drying, and thus enhanced the ability of clay walls to naturally defend themselves.

With or without plasters, the natural qualities of clay and the especially thick walls of earth buildings drew them capable of their own care.

Traditional structures in Errol are found to have been plastered with clay or lime, while those in Normandy bear no plasters though some received a coat of lime in the 19th Century.[115]

Figure 36: Traditional Cob structures in Normandy were characteristic of wearing no plaster

- Roofs

Roofs of traditional buildings were detailed to steadily shelter and protect the structure. This was achieved with a strong and stable frame that upheld the roof structure; a thatch covering that in addition to providing a reliable covering made for natural insulation as well (As communicated by Jarema Dubiel; Earth, Hands and Houses), later slate and tile were used[116]; large overhangs protected wall surfaces from water and winds.

Figure 37: (a) A well supported roof with large overhangs protected the wall of this building, PNRMCB, Normandy – France

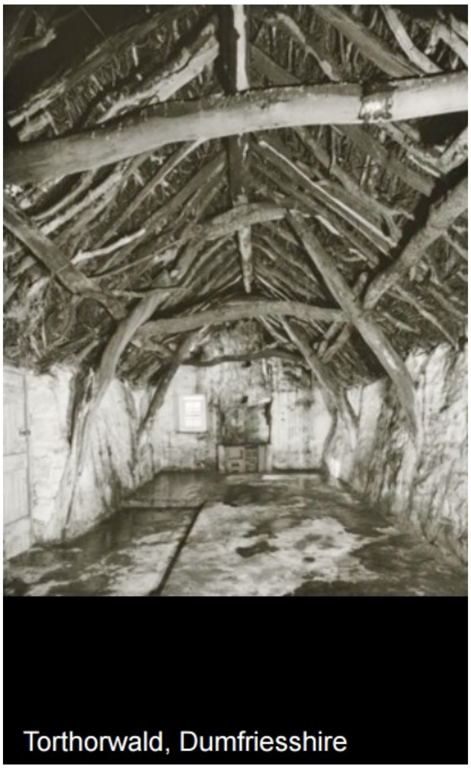


Figure 197: (b) In some parts of the United Kingdom, including Scotland timber crucks ensured the stability of roofs.

Furthermore, in Scotland, cow sharn i.e. dung without the fibre was applied on thatched roofs to act as a waterproof membrane.[117] As observed at the building occupied by Association Pierre et Masse, Normandy – France, plants like Iris were grown along the ridges of traditional roofs as their roots absorbed rain water and thus protected the buildings from water damage. (Figure 30)

6.1.ii Traditional lifestyles and systems

Traditional practices and beliefs seemed to have had a significant bearing on the care and sustainability of early buildings. In fact, their contribution to conservation might have weighed more than most tangible aspects of traditional culture.

However, as most traditions and beliefs laid embedded and hidden in the routines of everyday life, and – if observed and perceived minutely – often included daily activities and rituals that bore no intention of conservation, they remained unnoticed, unrecognised and unnecessary of mention. This lack of transparency led to the lack of acknowledgment and worth attached to the role traditional lifestyles are likely to have played in conservation… and continues to be the case…

Even more so, now that traditional lifestyles have disintegrated to give way to modern living, it is even more difficult to trace and fragment aspects of traditional life that integrated a culture of conservation and self-sustenance. This study however, was able to unearth some legends, folk stories, and practices from different parts of the world – that conscious, subconscious, or unconscious to the mind of traditional inhabitants – largely contributed to the upkeep, longevity and allied sustainability of traditional buildings.

- <u>Burning fuel and incense in houses keeps dampness and insects away – India</u>

In India, which is home to numerous clay building traditions, various rituals involve the burning of fuel and incense on a daily or occasional basis and the smoke and essence it gives out keeps dampness and insect infestation on walls at bay.

Such rituals include:

- In some regional Indian cultures, the daily activity of cooking is performed on traditional stoves inside the house.

Figure 38: Traditional cooking inside the house gave out smoke that kept insects and dampness away from earthen walls – India

- Incense sticks are often left burning for religious reasons or for fragrance.
- In the Indian state of Goa, frankincense is flamed and fumigated during religious occasions, wedding rituals, after bathing infants, etc. The reasons may vary from beliefs like warding off evil, inviting good omen, or just keeping mosquitoes and other insects away and sanitising the space.

- <u>The guardian force ‘*Rakondar*’ that kept drains and thus dampness in check – Goa, India</u>

In Goa, there is an old ‘belief’ in the existence of a good spirit, locally referred to as ‘*Rakondar*’ (guardian). This respected and sacred force was believed to walk along drains, and so the local people would ensure regular repair and maintenance of their drainage system, which in turn prevented waterlogging in the area and protected buildings from damp. The *Rakondar* was/is believed to guide and protect one while journeying into the deserted dark of the night especially during the time before electricity was introduced; however, one was not supposed to turn back and look, as the existence of this force was only meant to be sensed or felt. Stories of the *Rakondar* continue to be widely popular among the older generation, though the belief surrounding its connection with the drains is vocal only amongst a very few.

- <u>Planting trees that would provide for the upkeep of homes – Goa, India</u>

An example of sustainable conservation is the growing of local tree varieties at the time of building one’s house, with a vision that they grow along with the owners and provide for upkeep of the house and the owners themselves when they are old and maybe fragile to fend for necessities. Teak, bamboo, mango and jackfruit trees were particularly popular in Goa. Teak provided wood for the repair and replacement of traditional pan-tile roofs, which after a few years of installation, might benefit from some attention. Bamboo provided the supply of raw materials required for weaving mats and baskets used in farming, which in turn supported some earth building techniques such as Cob. Mango and Jackfruit were popular for their wood as well as fruits.

- <u>Burying lime at the birth of a male child provide material for his future house – Poland</u>

According to a Polish tradition, a family would bury lime on the birth of a male child, so that it ages to quality and provides a durable plastering material for the heir when he grows to be 25 – 30 years old and is ready to repair his ancestral house or build a new one. (As communicated by Jarema Dubiel; Earth, Hands and Houses)

- <u>Smoke from fireplaces in blackhouses helped preserve roof material – Scotland</u>

The blackhouses of Scotland left fireplaces burning constantly which combined with the thermal properties of the clay used in the construction (peat, mortar, etc.) and kept the building both, lighted and warm; the further characteristic lack of ventilation in the structure retained much of the rising smoke which helped keep insects away as well as benefited the preservation of the roof material.

In Scotland, Holly trees are believed to have been planted near the entranceway of houses in order to provide protection; significant amounts of iron deposits have been found near many traditional homes. These could hold some significance in conservation.

Figure 39: Holly trees planted near the entrance ways of traditional Scottish houses were believed to provide protection

- <u>Fireplaces prevented insects from floor beams; lime disinfected animal sheds – France</u>

Smoke from fireplaces in many French houses contributed to guarding floor beams against insect attacks. This has been particularly observed at the manor house at Saint-André-de-Bohon. (As communicated by François Streiff; PNRMCB)

Farmers in France periodically painted animal sheds with lime to disinfect the space. (As communicated by François Streiff, PNRMCB). This may account for 'Preventive Conservation' as well as a tradition that contributed to conservation.

6.2 Conservation Approaches Today

Today, heritage conservation is a formal practice and technical science, and seems to have stemmed from the current generation's inheritance of several and dilapidating heritage entities that are demanding obvious urgent intervention.

The essence of 'conservation' lies in performing just enough intervention so as to minimize further damage and prolong the life of the building to its maximum longevity. It differs from restoration, renovation and recreation, which aim at undoing, upgrading or reconstructing certain parts or whole buildings. These however, are important as extensions of conservation, legitimate of consideration.

It is rather difficult to draw the line between conservation and its mentioned counterparts. Any degree of intervention on a traditional architectural fabric is a step(s) away from its originality or authenticity… In this light, how much conservation is too much conservation is often the daunting question.

Conservation is indeed a wide approach and in most cases, it is difficult to define 'A' single solution for 'A' given problem. Every problem has to be analysed and addressed in context of its cause as well as the structure of the building, its history, location, etc. The final decision is often at the judgement and discretion of the conservator(s) involved. In the utter juxtaposition of situations, as is often the case, certain ethics and ideologies serve as basic guiding points:

- Minimalistic intervention:[118]

'Less is more,' is the principle! The slighter the degree of intervention to address and solve a problem, the better is the result. This is so that as much as possible of the traditional fabric is retained and the authenticity value of the building is guarded.

- Sympathetic repair:[119]

Materials and methods employed in conservation should be weighed for their appropriateness and compatibility with the original structure. Material composition, historical qualities, traditional methodologies, aesthetics, etc, are factors to be considered.

The ideal repair material is often one that closely matches the original building material, however, various other factors like the nature of the material to gradually weather and eventually synchronise with the traditional fabric should be favoured over replicating materials, colours, textures, etc. Implementation of non-traditional materials should be avoided but if considered, as sometimes the case may be, care should be taken that it does disturb the integrity or traditional fabric of the building.

- Reversibility:[120]

Conservation interventions should be capable of being withdrawn, making it possible to reveal the original fabric, and provide scope for better conservation implications that might be discovered in the future. The latter is especially true as conservation is a growing science and new and better practices are continuously being introduced.

In addition, the process of recording and documentation is proving crucial in the field of conservation. While past records are important sources of information, modern experiments and technologies like lasers and photogrammetry provide the possibility of gathering information in bounds and ways that might not have been possible a few decades ago – recording and skilfully archiving new findings will offer ground and set the pace for future conservators.

These are general conservation principles applicable to architectural conservation. The conservation (and construction) of earth buildings, however, as an entity in itself, bears further implications and ideologies; the most fundamental one expressed by the term…

- ‘A stout pair of boots and a good hat’[121]

This refers to a strong foundation and a firm roof. If these two aspects of a clay structure are rightfully detailed and treated during as well as after construction, the building is sure to serve generations!

6.3 Technical Conservation of Earth Buildings

The building and upkeep of earth buildings has always been a simple process, until its ruinous vestiges in recent times evoked the consciences that these buildings are in an urgent need of attention; thus began deliberate conservation interventions on earth buildings. The science of material, technology and repair of earth structures is still in its infancy stage and is the process of being developed.

Two factors that might be worth considering before carrying out any repairs on earth constructions are:

6.3.i Specific methods for estimating age

Testing the actual building soil to determine the age of the building is often not considered as its results tend to reveal the geological age of the soil rather than the age of the building. If the age of the building is not found from past records, it is usually estimated through the method of dendrochronology, which involves dating the timber used in construction. This however, may not deliver accurate results as there is the possibility that the timber was salvaged from another, previously existing structure and thus the estimated date may be older than (hence incorrect!) the actual age of the building being analysed.

Methods of testing building soil aggregates like, straw and other fibres, which might be especially beneficial for dating Mudwall/Cob buildings are also being considered.[122] New methods like optical dating, which analyses soil components like quartz and others are now being discovered.[123]

Traditional buildings sometimes have the date inscribed on them and is essentially the simplest and best way to gather the age of the building.

The Cottown Schoolhouse in Perthshire for example, has the date ‘1818’ inscribed on its chimney.

Figures 40: (a) (b) The date of construction inscribed on the roof truss of a house, Goa – India

6.3.ii Understanding, preparing and testing

Understanding of soils prepared for repair/building is gained by analysing and testing dry soil samples picked from the structure to be conserved. These reveal the material composition of the original building material and set ground for producing a repair material that would match and agree with the traditional structure. Soils for repair and building thus follow a similar – if not the same – process of preparation and testing. Basic understandings of soils used in buildings remain the same.

The preparation of the ideal soil for repair/building is a mix of various particle sizes, and organic and inorganic materials, and is aimed at achieving a material that is flexible to work with, and results in a stable and strong structure. The soil is worked to achieve a mix that – in its appropriate levels of porosity, volume, density – poises malleability, plasticity, tensile strength, cohesiveness, compaction – thus reducing shrinkage and cracks on drying, and making for a repair/building material, and ultimately a building that is strong and lasts long!

If measured for its composition, building soils majorly contain silts and clays; other aggregates like grits, gravels, including calcites like lime, chalk, etc. are also present and important. The presence of various particle sizes and shapes allow for better compaction, transfer of stress and adhesion.

Soils used in construction can be roughly classified based on their particle size and composition, and are explained below.

- <u>Classifications based on particle sizes:</u>[124]

Particle sizes are expressed in micrometres (which is one millionth of a metre); the symbol used is 'µ.' (1 micrometre = 1 millionth of a metre = 1µ)

Soil particles	**Sizes**
Clays	usually 0.1 – 2 µm, can be up to 20 µm (i.e. up to 0.002 mm)
Silts	20 – 6000 µm (0.002 mm – 0.06 mm)
Sand	More than 6,000 µm (more than 0.06 mm)
Grits	2 mm – 5 mm
Gravels	More than 5 mm

- <u>Classifications based on particle composition:</u>[125]

Soils containing high aggregates of sands and gravels are generally termed '*sands*;' soils with high concentrates of silt and clay are called '*loams*;' and those which constitute of more than ⅓ quantities of clays are simply referred to as '*clays*.'

Sandy soils are porous and have low cohesion ability, and are thus not fit for repairs/building; loamy soils with their varying particle sizes make for better cohesive strength, and though preferred, especially for Mudwall/Cob repairs/buildings, lack further needed binding strength; soils with high content of clay pose high water absorption ability, and on drying increase shrinkage and fissures and thus reduce in strength.

Water is an important component as it acts as a binder and lubricant. Soil prepared for repair/building, in its malleable and plastic state, contains about 15% – 20% water by weight, more water content would cause the soil aggregate to lose adhesion and hence collapse.[126]

Sometimes, various proportions of particle aggregates, organic and inorganic materials like straw, fibres, lime, gypsum etc. are added in soil preparation depending on the nature of the naturally occurring soils and the construction technique in which it is intended to be used. For example, higher content of gravel is often employed in the rammed earth technique[127] as it contributes to compaction, (Figure 11) straw is for Mudwall/Cob repairs/building to provide binding strength, gypsum may be added to some mixes to increase binding strength and cohesion, etc.[128]

Further, the composing of the ideal building soil is subjected to the inherent qualities of its organic and inorganic components. These, in their natural micro-environments and or their devised chemical compositions, vary widely in characteristics, such as particles shapes which may be sharp or rounded, as well as in their behaviour, especially in constitution with other occurring components and minerals in the soil.

Specific to repairs, acquiring the ideal, like-to-like material that exactly matches the original building material poses various challenges. For example, in Errol, the clay pit(s) from where building soil was sourced cannot be accurately traced and hence material for repair is sort from alternative sources. Besides, exact proportions of aggregates in the building soils are rather impossible to achieve given that exact measures were never the norm in traditional times and the final composition was often a by-product of the availability of materials, and the sense of estimation applied by the builder. As soil was prepared and implemented in batches, the proportion of aggregates often differ between lifts of the same building.[129] As in traditional times, modern conservators today rely on their tact and judgement in preparing material for repair/building.

How then do we achieve the ideal soil for repair/building?

Well, there is NO guaranteed formula for composing the perfect soil for repair/building. Available and prescribed proportions of aggregates only provide direction.

Various tests however, have now been devised to aid in determining soil characteristics and its suitability for repair/building.

Some of these include laboratory tests, which are expensive and most often than not – unnecessary. Simple field tests are reliable in revealing the proportions of particle sizes and judging soils for repair/building. Some of these tests include:

- Using a jar:

This method is usually used for estimating proportions of particle sizes in soils of already existing structures and thus provide direction in preparing soils for repair. It can also be used to test natural and untampered soils and accordingly suggest suitable aggregates that may be added to prepare the soil for construction.

This methods makes use of a clear jar with a flat base. It is half filled with water, and a dry soil sample broken off from an existing building or a handful of naturally occurring soil is dropped into the jar to quarter fill it with the aggregate. The jar is then left for a few hours till the particle sizes settle in layers according to their weights: gravel at the bottom, topped with sand, silt and clay forming the uppermost layer. These are then measured to provide estimations in composing repair/building material.

- Making a clay roll

This method is mainly beneficial for testing soils already prepared for building. In its malleable and workable state, a small portion of the mix is rolled between the palms of your hands to form a roll; on bending it provides indications of the proportions of soil particle sizes. If a roll of about 50 x 3 mm breaks before it is bent to 45°, it is indicative of too much sand content; if it breaks after it is bent to 90°, it indicates too much clay content[130] – either of which are not desirable for building.

- <u>Holding a handful of clay:</u>

This method too is useful for testing prepared soil-mixes. It involves squeezing a lump of clay in a fist. If on opening the palm, the lump breaks, it signifies excess grit; if it is wet and sticks to the palm, it is suggestive of excess clay; but if stays as a lump and takes the imprint of the palms, it is perfect for building! This traditional test is recorded to be common in Scotland.[131]

Figures 41: Soil testing (a) using a jar (b) making a roll (c) holding a handful of clay

An experienced conservator is often able to estimate the qualities of soils by simply examining them with the naked eye and touching them, and deriving information from the soils’ colours, textures, etc.

In the Carse of Gowrie, soils have been studied in context of the existing clay buildings of the region (Figure 21 (a)); results prove that traditional inhabitants had a good understanding of their soil resource and made effective use of it in construction and repairs.

6.3.iii Damages and repairs

Various kinds of damages are observed to have been incurred by earth buildings and plausible technical repairs have been accordingly suggested. However, the fundamentals of conservation weigh in analysing the problem and deciding on the extent of intervention.

This sections addresses damages and probable technical repairs – these however, only provide guidance, and whether and how they are implemented would vary according to the various factors surrounding the problem and the structure. It is recommended that repairs be attempted ONLY by a trained conservator – uniformed diagnostics, decisions and interventions can prove to be detrimental to the health and safety of the building and its inhabitants.

Certain regions are found to be more vulnerable to certain kinds of damages than others. For example, rain prone areas are subjected to damages like water ingress, while regions of extreme cold climate might face problems of crystal formations in the walls, etc.

In Errol, Carse of Gowrie, Perthshire – Scotland and the PNRMCB, (Lower) Normandy – France, some common damages have been observed. These are addressed below.

- <u>Impermeable renders and plasters:</u>
  - Damage and cause:

Impermeable cement renders have been the cause of deterioration and loss of many buildings in Errol and the PNRMCB region.

The introduction of cement as a readily available, and quick and easy to use material replaced the more natural and relevant clay and lime renders and plasters. The seriousness of the damage it results in has surfaced only recently after having lost many traditional buildings.

Cement is a hard and impervious material. When coated on earth buildings, it blocks away the clay walls' natural ability to allow for air circulation, and hence dry and reinstate themselves in case of moisture penetration. In fact, cemented walls trap water that might have seeped into the structure through surface cracks, from the ground, drains, rains, gutters, etc, and causes the walls to degenerate from within. Externally, the building continues to appear healthy.

The crumbling structure often reveals itself after years, as the expanding force of the moisture levels eventually causes the cement to crack, warp and finally break off in pieces and fall from the structure. Even worse, sometimes, a disintegrated and hollow –hence no wall – reveals itself while repairing an existing plaster. Besides, the removal/replacement of cement involves the continuous striking of a hammer and chisel, and cement being a harder material than the clay and wall behind it, might have an impact on the long-term structural integrity of the building.

Figures 42: (a) (b) (c) A 100 years old Cob building suffering damage caused by cement rendering – Poland

Figures 43: Damage caused by cement (a) structure in Normandy – France
(b) Structure in Carse of Gowrie – Scotland

- Recommended repair(s):

It is best not to use cement renders at all in the repair, renovation or restoration of traditional buildings.

However, if cement coats from past interventions exist, it may be suggested that they be taken off and replaced with earth or lime plasters, which are of equal or softer strength than the underlying wall, and thus allow for repairs without disturbing the core structural form of the building.

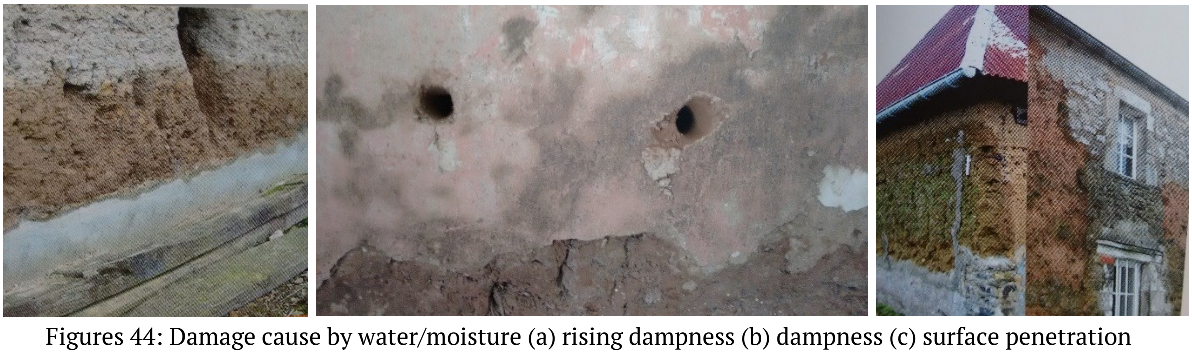
Earth plasters bear an obvious compatibility with earth building. Lime plasters, on the other hand, may often came across as being prone to chipping; however, the strength of lime plasters lies in them acting as 'sacrificial layers' that shed themselves in the process of releasing moisture that has entered earth walls. Earth as a building material is by itself is capable of evaporating penetrated moisture; permeable plasters act of further protection, and thus though seasonal coatings may not be necessary, do benefit the structure.

Replacing cement renders requires the preparation of earth or lime plasters; simple tools like a hammer and chisel for removing existing cement; and mixing tubs, trowels and floats for applying the new plaster.

Much of today's conservation work involves the removal of cement plasters to repair buildings and replace them with clay or lime plasters.

- <u>Water/Moisture Damage:</u>
  - Damage and cause:

In Errol and the PNRMCB, various kinds of damages caused by water/moisture have been noticed: rising dampness, surface penetration, water runnels, etc.



Figures 44: Damage cause by water/moisture (a) rising dampness (b) dampness (c) surface penetration

In these and other rain prone regions, water/moisture damage is often looked at as the main drawback of earth buildings. Water seeps into the walls from ground; rains may cause water penetration and erosion on external walls; impermeable plasters trap moisture causing walls to disintegrate and cause them to lose adhesion; leaking gutters may create water runnels and gaps in the structure; etc.

- Recommended repair(s):

Clay buildings are inherently accustomed to wetting and drying cycles and are capable of monitoring water/moisture levels that occur through natural processes, like the capillary rise of water from the ground.

Exposure to rains especially in direction of the wind (that is North-West for Errol and the PNRMCB) can be reduced by large roof overhangs as well as by planting shrubs and trees close to the structure. The latter obstruct and reduce the amount of water that comes in contact with the building as well as soak excess runoff that might otherwise damage the base of the building.

Further, a well-thought network of drains that is placed away from building and regularly maintained to ensure that water does not accumulate but flows away is capable of eliminating the problem of groundwater seepage; likewise gutters positioned away from walls and well-detailed roof covers that receive regular maintenance are capable of eliminating problems of surface water seepage and water runnels.

In the case of impermeable plasters, it is the failure of repair/restoration material that is primarily responsible for the damage incurred by water.

As apparent, it is often the lack attention and care of factors surrounding the structure that makes clay structures vulnerable and exposes them to water damages. Water damages on earth structures are easily and best prevented than solved.

- Cracks:
  - Damage and cause:

Figures 45: (a) (b) (c) Cracks on walls

In Errol and the PNRMCB, large cracks are observed mainly along building corners and near doors and windows, and small fissures may be noticed all along walls. While the bigger cracks may indicate structural problems and require professional intervention, the smaller ones are likely to be the result of shrinkage.

The reasons for larger cracks vary. One of the reasons that could be attributed to large vertical cracks in the buildings of these regions is that, as the natural seasonal cycles of wetting and drying occur, they might have combined with the weight of the building to cause movement in the ground or subsoil setting; this in turn might have affected the distribution of load at the foundation and consequently the roof, thereby causing large vertical cracks.

- Recommended repair(s):

In accordance to the cause of the problems and consideration of various surrounding and influencing factors, a suitable treatment(s) is suggested. However, before carrying out repairs, it is often important to check that any movement that might have been responsible for the cracking has stopped and stabilised – if not, cracking is likely to continue even after repairs.

One way of repairing a crack is by the process of '*stitching*.' It requires some fresh cob-mix, preshrunk-cob-blocks and simple tools like a hammer and chisel. The first step of this intervention might often involve trimming away some part of the cob wall along the crack in order to define the spot for repairs – care must be taken not to cut away too much. A preshrunk-cob-block is cut to fit to a slightly smaller size than the opening of the crack. The opening is then moistened with water using a brush, and a cob-mix is applied along the inside to act as mortar; the cut cob-block is then placed in the cavity and further concealed with the cob-mix, which at this step, may act as a plaster. Though the process is best restricted to the use of natural materials, sometimes a stainless steel, twisted metal rod i.e. a helibar may be used. Depending on the length and nature of the crack, this process might be repeated along the crack.

Figures 46: (a) (b) (c) (d) The '*Stitching*' process

Various other damages are noted to have incurred by clay structures in Errol and the PNRMCB. These include those caused by pests and animals: holes bored by masonry bees, abrasions caused by animals brushing against entranceways of sheds, erosions as animals licked damp wall footings for the taste of the salts that accompanied the capillary rise[132]; biological growth on walls, whose roots might cause cracks and weaken the structure; gable failure instigated by roof failure: decay of timber and structural failure, shift in weight, etc.

Problems in clay buildings are often interlinked and a series of solutions can be suggested. However, most of the times, regular maintenance of site drainage and gutters, which tend to have a large bearing on ensuring the health of the building's foundation and roof (good boots and good hat!) are the keys to conserving a clay buildings.

6.4 Socio-Economic Challenges and Opportunities

Socio-economic challenges faced in the conservation of earth buildings often limit the extent and pace of conservation activities and building protection. Fortunately, these challenges are often allied with opportunities.

- <u>Social image</u>

Earth building as an age old tradition that was heavily replaced by new and swanky looking materials, came to be associated with low social status and poverty. As the tradition began to decline, existing buildings received little maintenance and incurred obvious wear, which further dethroned the material as weak and aesthetically unpleasing. Earth buildings are thus often looked at as a poor man's poor building material, which hampers the survival and revival of this tradition.

In reality however, back in history, earth building knew no socio-economic implications, it simply stemmed from the local availability of soil and reliability as a building material. The Alhambra Palace in Spain and the Antonine Wall in Britain are clear examples. Fortunately today, earth has begun being recognised as sustainable, durable and flexible building material, capable of being moulded to sport innovative designs.

- <u>Knowledge, skills and guidance:</u>

The major challenge currently faced in the conservation of earthen heritage is the loss of traditional skill and knowledge coupled with insufficient documentation. The lack of understanding of this traditional craft has led to uninformed decisions like the use of cement renders and UPVC doors, which in their incompatibility with earthen buildings are responsible for the loss of many traditional buildings or their fabrics.

The above often were well-meaning actions aimed at the care of buildings. In Errol at least, many owners and occupiers recognise and are proud of their distinct built clay inheritance,[133] and would benefit from guidance on how to maintain their structures. Fortunately, in both regions, Errol and the PNRMCB, a few professionals have taken the lead to gain understanding and trainings in this traditional craft, and have been effectively documenting, delivering guidance and training future professionals. In France, for example, institutions like AFPA and GRETA, involved in adult education have now incorporated vocational trainings in earth building.[134]

- Finance and recognition:

Conservation of earth buildings is a science in its formative stage with little available expertise, it can hence be expensive to carry out repairs using the appropriate, traditional techniques. Lack of understanding and recognition of earth as a building material, sometimes also makes it difficult to procure mortgages and insurances. Lack of statutory protection too, lends little funds to the cause of conservation and revival of this valuable heritage. Besides, some occupiers also refrain from such protection, may be for reasons of limited support and or any clauses they might have to oblige to.

Nonetheless, earth buildings have of late begun receiving their due recognition and efforts are being made towards their survival and revival. Various initiatives such as the World Heritage Earthen Architecture Programme (WHEAP) supported by United Nations Educational, Scientific and Cultural Organisation (UNESCO) are being executed. In regions concerning Errol and the PNRMCB, local authorities like the Perth & Kinross Heritage Trust, and the PNRMCB itself have noted the earthen buildings of their regions as a conservation priority. In Errol particularly, an awareness and interest has spread and some inhabitants are fondly, willing to partake in the protection of their earthen heritage. The owner of Flatfield Barn – Carse of Gowrie, for example is active in the conservation of the building.

3. COMPARISON: EARTH BUIDING TRADITION OF PERTHSHIRE – SCOTLAND AND NORMANDY – FRANCE

In the earth building traditions of Errol, Carse of Gowrie, Perthshire – Scotland and the PNRMCB, (Lower) Normandy – France, various similarities and differences have been observed. These interestingly, occur in varying degrees and patterns between as well as within the two regions.

Studies concerning the earthen heritage of both the regions have been conducted. These, carried out by their respective local authorities, follow their own distinct approaches and in this respect, are driven and credible. As would have been desirable for a comparative study as this, however, the varying approaches may not deliver balanced sets of data. For example, while all types of buildings have been recorded in Errol, documentation of the PNRMCB tends to be restricted to farm buildings. Despite, based on the available studies, certain similarities and differences can be inferred.

7.1 Similarities

<u>Architectural identities and their evolution:</u>

- Most structures recorded in the two regions date to the 18th – 19th Centuries, which coincide with the heydays of architectural activities in both regions.

- The *Mudwall/Cob* technique is the most commonly found earth building practice in both regions, followed by its *stake and rice/torchis* variation(s). (Refer: *4.3.ii Terminologies and techniques*)

- Various characteristic features imbibed in construction are similar in both regions: front facades facing the South/South-East direction, stone plinths and wide bases, traditional use of thatched roofs that came to be replaced by slate and other materials, etc. (Refer: *6.1.i 'Preventive Conservation' or 'Defensive Conservation'*). On the internal walls, small dents are clearly visible in the structures of both regions, indicating the use of the fork tool in construction. (Figure 26(b), 45(c))

- Both regions witnessed agricultural evolution and decline, industrialisation and modernisation, migrations and depopulation, introduction and popularity of new building materials, etc, which gradually changed the architectural identities of the regions.

- Brick came to be widely manufactured in Errol and the PNRMCB.

- Traditional knowledge and skill concerning the earth building tradition were dethroned and are now essentially lost.

<u>Damages and conservation approach:</u>

- Similar kinds of damages are observed to have incurred by earth structures in both regions, such as effects of impermeable plasters, water ingress and consequent failure of plasters, loss of roofs and gables, etc. (Refer: *6.3.iii Damages and repairs*)

- Efforts towards the survival and revival of earth buildings are being made in both regions.

7.2 Differences

Architectural identities and their evolution:

- The earthen architectural landscape of Errol is smaller with buildings existing in close proximity to each other. While the PNRMCB is a vast green landscape with dotting Cob buildings making their inevitable presence.

- A few 16th Century buildings have been identified in the PNRMCB, no buildings pre-dating the 18th Century have been recognised in Errol.

- Distinct variations of the Mudwall/Cob techniques exist in both regions; appellations vary too. '*Mudwall*,' '*Masonry-faced Mudwall*,' '*Stake and Rice*,' etc, in the Carse of Gowrie, and '*Bauge*,' '*Torchis*,' etc. in Normandy. (Refer: *4.3.ii Terminologies and techniques*)

- In the PNRMCB, there is one building constituting the '*Pisé*' method, while Errol records no rammed earth. This methods reads to have developed in France and might have been introduced in Scotland by various sources – it is less popular in Scotland.[135]

- In employing the Mudwall/Cob technique *lift* sizes range from 0.002m – 0.30m in the Carse of Gowrie, and 0.60m – 1.20m in Normandy.

- Buildings in Normandy display putlog holes indicating the use of scaffolding, such have not been noted in the Carse of Gowrie. (Figure 12(c))

- In Errol, most buildings are raised to one or two storeys, while in the PNRMCB, they are built up to three storeys.

- Roofs of tile and tin as a replacement of thatch is more prominent in the PNRMCB, and is (almost) absent in Errol.

- In Errol, stone was not indigenously available, while in the PNRMCB, it was natural resource in some regions. Stone was thus not used at all in the traditional construction culture of Errol, while in the PNRMCB, its use is seen in buildings surrounding the regions where it was accessible.

- In Errol, external facades of buildings received lime renders. In Normandy, buildings were not rendered, until the 19th Century, when lime coatings started gaining fad.

- While in the Carse of Gowrie, buildings gradually came to be clad with stone/brick, in Normandy, stone seemed to have been imbibed into the structure at the time of construction itself, as plinths and fenestration encasements. These in themselves could be ‘conservation’ measures.

- One of the last earthen building(s) recalled to have been built in Errol was in the 1970s, while in the PNRMCB, documentation suggests that the last were built in the interwar period.[136] Thus, the clay tradition seems to have lived longer in Errol (till the second half of the 20th Century) than in the PNRMCB (till the first half of the 19th Century).

Damages and conservation approach:

- In Scotland, in addressing the risk of erosion at wall footings caused by animal licks, masonry claddings are recorded to have used as a preventive measure.[137] This has not been observed or recorded in Normandy – France.

- Structures in Scotland display the wide use of puddle clay as a water repellent. In Normandy – France, this has not been particularly noticed.

- In the PNRMCB, traditional buildings are now being rendered as a conservation measure, to protect the walls of the building. Restoration, reconstruction and rehabilitation as extensions of conservation are more active in the PNRMCB.[138]

- Smoke from the fireplaces in Scotland and France seemed to have served a purpose in conservation. In the black houses, it helped preserve roof material and in the French houses, it protected wooden floor beams from insect attacks.

However, as thatching material and wooden floorings were similar in both regions, fireplaces could be attributed to have contributed to conservation in both regions.

7.3 Difference within the regions

Errol, Carse of Gowrie, Perthshire – Scotland

- Within the *Mudwall* and *Stake and Rice* technique in Scotland, there exist wide variations in *lift* sizes, armatures employed, masonry skins, etc. For example, in Dumfries, the *lift* size is about 0.15m – 0.20m while in Errol they ranges higher;[139] in the armature of the Cottown Schoolhouse, rope has been discovered in addition to wood; buildings in Errol may or may not feature masonry claddings, if they do, they may be in stone, brick, or both. (Refer: *3.2.ii Terminology and constructions techniques*)

- In the Carse of Gowrie, external facades were traditionally lime rendered, prime rooms also received a plaster, while secondary spaces like attics and storages were left bare of such coatings.

PNRMCB, (Lower) Normandy – France

- While clay is an abundant resource along the Basin of the PNRMCB, stone is is a naturally available only in some regions of the park.

- Within Normandy, *Cob lifts* heights vary from 0.60m – 1.20m and the technique and its appellations occurs in variations such as '*gazon,*' '*Caillibottis*,' etc. (Refer: *4.3.ii Terminologies and techniques*)

- Structures that belong to the 16th – 17th Century are characteristic of wide foundations that slant and narrow upwards; those of the later centuries display stone plinths.

- Depending on the era during which the structures were built, stone has been employed to various extents, often forming interesting patterns on the building.

- The architecture of the land displays a rich chromatic palette owing to the varied geological resource of the region. (Refer 4*.2 Reasons for the Presence and Survival of the Distinct Mudwall/Cob Walls*)

- In the 18th – 19th Century, as stone became more accessible, its use was particularly sorted in the building of residential houses – outbuildings often remained in Cob.

- Within the PNRMCB, in the Basin, the earth building tradition reached redundancy in the last quarter of the 19th Century, while in the Cotentin it lived till the first half of the 20th Century.[140]

In addition, in each of the two regions, there occur variations in wall thicknesses, varieties of soils and stones used, size of buildings and number of storeys, diversity in building features due to the changing trends in the past, etc.

8. CONCLUSION

Earth buildings are rooted in the soils of the land they are built on. This architectural expression is webbed in the environments, traditions, cultures and identities of regional localities. The sum of these locally relevant, built manifestations has resulted in a worldwide tradition that is distinct in itself as well as in bearing characteristic variations between continents, countries as well as within localities.

However, the earth building tradition faced redundancy. Of late, rightfully, it has remerged for its scope as a quality building material harbouring potential to address global issues like economic housing and sustainable development. Efforts towards its survival and revival are well on their way.

Having studied the various approaches adopted towards the care and protection of traditional earthen buildings, it is an understood fact that modern conservators have little option but to resort to a rather modern understanding of this traditional craft. In a sincere attempt to find factual information, efforts have lengthened to scientific approaches and laboratory testing, which have delivered significant results. However, interestingly, professionals with experience in scientific approaches as well as that of simple field-work that involves mere observing, touching and smelling the structure – vouch on the reliability of the latter, especially when it comes to actual implementation of repairs on buildings.

It is rather amazing how traditional entities best respond when approached by traditional means.

This study drew me to yet another – rather ignored – or more accurately, rather hidden – traditional treatment that if approached effectively can add a new dimension to modern conservation. Traditional lifestyles and systems seemed to have had an important bearing on the care and longevity of buildings, and if delved into enough and feasibly imbibed into modern and technical practices, these poise the scope of rendering conservation more affordable, simple and with less risks of after-effects. For example, in the repair of masonry bee damage, burning frankincense can be used to ward away the bees before the holes are filled up with prepared soils.

Traditional and modern approaches clubbed together in the purpose of care and protection of traditional buildings can thus enhance the conservation approach.

In adopting traditional methods in conserving traditional buildings, we are conserving not only the tangible heritage i.e. the built structure but the intangible aspects that are allied to it as well – thus tallying a holistic approach to Architectural Conservation.

APPENDIX

Case study: Cottown, St Madoes, Perthshire

(An excerpt from Walker, Bruce, and Christopher McGregor. *Earth Structures and Construction in Scotland: A Guide to the Recognition and Conservation of Earth Technology in Scottish Buildings*. Edinburgh: Historic Scotland, 1996.)

The former school and schoolhouse at Cottown is a predominantly mudwall structure, recently purchased by the National Trust for Scotland with grants from the National Heritage Fund and Perth and Kinross Heritage Fund. Conservation works have been undertaken in partnership with historic Scotland with the assistance of a Historic Buildings Council Grant.

The building, dating from 1745 with rebuilding in 1766 and 1818 presented many challenges as it was the first mudwall structure to be conserved in Scotland. To allow freedom in the investigation and conservation works an agricultural shed was erected over the entire structure.

A method of working was devised, that allowed for the careful removal of damaging impermeable plasters and renders whilst retaining the structural integrity of the building .This was essential as the building had been subjected to flooding prior to purchase by NTS and the base of the earthen walls, sandwiched between impermeable renders, was still drying out . The removal of the external cement renders was carried out by the authors, assisted by Gregor Stark of Historic Scotland. Several areas of cement render were left insitu at the time to ensure structural integrity but as much as possible was removed to allow drying and further investigation of the structure. At this stage the integral renders were left insitu.

A former Historic Scotland lime internee, Rebecca Little, who had gained some experience of earth construction in Denmark, Devon and Lincolnshire was appointed as the contractor for the conservation of the earth structure. She agreed to work with various groups of volunteers. These included the National Trust for Scotland Volunteers; conservation and architectural students from Duncan of Jordanstone College, University of Dundee, conservation students from Heriot Watt University, Edinburgh; architectural students from Robert Gordon's University, Aberdeen; interested individuals; and classes of local primary school pupils.

The mudwall required: indenting at the base were there was a combination of erosion and rat runs; replacement of some poor quality sandstone blocking that was slack and obviously letting water into the wall (other small blockings that were sound were left insitu); plastic clay mortar filling to internal rat runs; plastic repairs to shallow hollows in the wall surfaces and to the wall-top of the gable; mechanical ties between the mudwall and a poor quality sandstone-clay mortar panel in the south elevation and analysis of the earth renders the lime renders from various parts of the building.

All indenting was carried out using pre-shrunk mudwall blocks and tiles, prepared over the winter months and air dried within the building. The original mudwall mix incorporated straw but the straw available locally had been grown using intensive nitrate fertilizers resulting in a poor quality straw. Locally grown flax was also available and although the vegetable material of the flax straw also broke down readily, due to a high free-nitrogen content, the fibres improved the tensile strength of the blocks. The blocks were trimmed to size using a Danish tool, designed for the careful removal of plasterwork, which looked like a hammer sized mattock. The blocks were bonded with an earth mortar of similar mix to the block but omitting the larger aggregate.

After the consolidation of the external surface of the external walls, the same process was repeated in the internal faces. There the impermeable cement render tended to be at the base of the wall, almost as a continuation of the cement screeded concrete floor. Archaeological investigation of parts of the floor failed to reveal the original construction and it has been decided to leave the concrete floor as found. This will necessitate the formation of land drainage round the property directly under the drip from the thatched roof to minimize the likelihood of rising the damp walls.

One of the internal walls is of kebber and the motte construction and the flood damage to the base of that wall was repaired using a mixture of mudwall block and plastic repairs – mudwall block where the evidence had disappeared and plastic repairs where the original evidence had disappeared and plastic repairs where the original construction was obvious. The chimney flues are of similar construction but using lighter timbers. These support brick chimneyheads.

Lime plasters were retained internally and lime was used to replace the cement renders at the base of the walls.

A clay and turf ridge is being used to complete the thatch. This is a traditional finish in this area and can be seen on early photography.

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Institutions to approach for seeking experts in earth building and conservation:

- United Kingdom: Earth Buildings UK & Ireland (www.ebuk.uk.com)
- France: L'association Asterrre. (www.asterre.org)

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