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Building with Earth in Scotland: Innovative Design and Sustainability

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The important role that construction has to play in developing sustainability has been recognised by the Scottish Executive and the Department for Transport, Local Government and the Regions. This report was commissioned to assess the potential for new construction using earth in Scotland and the environmental benefits that could result. The study assesses the heritage of earth construction in Scotland in the context of a modern European revival and examines the use of earth in relation to the modern Scottish construction industry, highlighting opportunities for development.

Main Findings

- Earth is used as a construction material across the world. One third of the worlds population live in buildings made of earth materials situated across most climate zones. In the United Kingdom half a million people live in houses made of earth. There is currently a major revival of earth building techniques worldwide, and particularly in Europe.

- Scotland has an important tradition of earth construction, which died out in the 19th century. It is one of the richest traditions in Europe in its variety of regional building styles and is the base from which a modern revival can develop.

- Earth is suitable for modern construction. It can be used in many different ways in buildings including load bearing walls, thermal and acoustic insulation, finishes to walls and floors. It can be both durable and beautiful. It is particularly beneficial for internal air quality. Using earth materials can have significant environmental benefits, in particular, reducing carbon emissions and waste production. These are recognised as important areas where the construction industry has targeted improvements.

- Scotland has a small group of architects, builders and materials producers involved in earth construction. This group has links to the wider European sector, which is particularly advanced in countries such as Germany.

- There are many opportunities to develop this sector including further research, demonstration projects, establishing a centre of excellence, public procurement, establishing an official standard, and development of manufacturing capability and innovative partnerships within Scotland and with mainland Europe.

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The Scottish Earth Building Tradition

Earth was the principal material used in Scottish construction until the 18th century and Scotland retains a rich heritage of earth construction, with much regional variety. Many surviving buildings are not recognised as being of earth construction but Historic Scotland and others have been gathering evidence on this issue in recent years.

Traditional earth building practice could inform a modern vernacular for earth construction. Traditional earth building techniques, which are simple and labour intensive, could be adapted to modern forms of construction through mechanisation and prefabrication.

Surviving earth structures in Scotland illustrate the appropriate use of local materials, which has resulted in diverse and distinct cultural patterns. The maintenance of this cultural diversity and local knowledge is central to the debate on sustainability.

Why Use Earth?

The main reason for using earth materials is their excellent sustainability characteristics. These include low carbon emissions, efficient use of finite resources, minimising pollution, minimising waste, use of benign materials, local sourcing and biodegradability.

In comparison, the construction industry is recognised as currently being a major source of carbon emissions, pollution and waste production.

In the context of national priorities for reduction of the environmental impact of construction and reduction of greenhouse gas emissions, earth could make a significant contribution.

The use of local materials and skills for building has a positive impact on local and regional economies. This is most apparent in rural areas where earth building traditions have survived until recent times. A new earth construction industry in Scotland could have relevance for both rurally based economies that are in need of diversification, and for national priorities that promote sustainable rural development.

Earth as a Modern Construction Material

In countries such as France, Germany, Holland, New Zealand, Australia and the United States, earth materials are increasingly regarded as mainstream, with regions and suburbs where earth is the main construction material for modern homes.

Modern applications of earth materials have spread across the United Kingdom in recent years, in projects ranging from the Eden Centre in Cornwall to a visitor facility at Rowardennan in the new Loch Lomond National Park.

There are a wide range of earth materials and construction methods, which can fill a variety of roles within a building:

- Mudwall: a traditional monolith walling technique
- Rammed Earth: a technique akin to concrete construction
- Earth Bricks: easily produced by modern industry
- Compressed Earth Blocks: similar to earth bricks but with greater load bearing strength
- Light Earth: clays mixed with natural fibres as insulating fill in timber frames, or as blocks.
- Plasters: both as boards and traditional wet coatings.

Earth construction techniques are easily transferred into modern construction practice and the existing manufacturing base could be adapted to produce high quality earth materials. Earth materials can be demonstrated to comply with the requirements of the building regulations, financers and insurers and commonly generate a warm public reaction.

Conclusions Drawn From Project Case Studies

The study includes 12 case studies of buildings in Scotland and the wider European Union. There are many lessons to be learnt from these case studies which are relevant to the potential for new earth construction in Scotland. These include:

Traditional Scottish earth techniques evolved to take advantage of local skills and materials and respond to local conditions. This surviving earth building heritage provides the starting point from which it is possible to

develop a viable living tradition with social, environmental and economic benefits. Two case studies dating from the 18th and 19th Century illustrate the lasting qualities of earth, as well as good building design and construction practice which is being reinterpreted in contemporary construction.

The case studies demonstrate that there is sufficient and easy access to earth as a resource for building in a significant number of regions and localities in Scotland.

Several projects show that earth has the potential to be used to produce high quality building products. These can satisfy the requirements of existing construction industries in developed European countries such as Scotland.

The high profile of many new earth buildings is encouraging a wider acceptance of earth as a viable building material. However, care must be taken in order that these pioneer projects are examples of best practice. This requires careful planning, design and construction and also the sharing of knowledge. Demonstration projects, which involve monitoring and research during and following construction, could encourage the dissemination of practical knowledge and experience.

The body of expertise for earth construction is currently very small in Scotland but it has the potential to grow as more projects get underway. The new earth buildings that have been completed demonstrate that there is sufficient experience and interest across manufacturing industry, design professionals, academic researchers and building procurers to successfully construct buildings using earth materials. However, training and education will be critical for wider use of earth in building. The experience of specialist contractors has a significant role to play in this transfer of knowledge.

There is also a significant resource of experience in mainland Europe and this should be utilised by those wishing to develop earth building in Scotland.

Opportunities for Development

A Centre of Excellence

The knowledge and skills base within the Scottish construction industry is currently very small. There is, however, a significant resource of experience in mainland Europe and this could be utilised by those wishing to develop earth building in Scotland. The potential for the establishment of a training, education and testing centre, similar to the successful Scottish Lime Centre could be developed.

Further Research

The information available in this area largely comes from foreign sources. There are opportunities for Scottish research, including collaborating in ongoing E.U. and DTLR research programmes.

Further detailed research could examine the scope for reduction of greenhouse gas emissions, and other environmental benefits, through the use of earth construction materials. Opportunities could be developed for materials research, both in the laboratory and in the field, into thermal properties, durability, structural properties and construction process.

Currently, there are suitable testing facilities for earth building materials in Scotland, but a lack of sufficient expertise to carry out the appropriate testing regimes.

Market Development

The current market for earth building in Scotland is small, concentrated in new 'green' buildings. The market in sympathetic materials for conservation of existing buildings could develop into another important base. There may be appropriate applications for earth construction in National Parks and special landscapes. The potential for the use of earth in the mainstream construction industry, as has happened abroad, could be realised by:

- Demonstration projects showing best practice
- Increased use in publicly funded projects
- The establishment of an officially recognised standard
- Easing of market constraints on 'innovative' materials, for example by the funding agencies

Opportunities for Industry

There is a realistic economic case to be made for the development of earth construction in Scotland. Initially this could focus on small buildings but larger projects may also develop as capability and confidence in the material grows.

There are currently no earth materials being mass produced in Scotland. Those being used are either imported or produced on a project-by-project basis.

There are opportunities for the existing manufacturing infrastructure to diversify into the production of earth-based materials and for innovative partnerships between industry, educational institutions and the public sector both within Scotland and with mainland Europe.

This would follow the pattern of European development. In Germany, for example, the market for these materials was worth £60m. in 2000 and is increasing annually by 20%, while the rest of the construction sector in Germany shows no growth.

About the Study

The study was undertaken between November 2000 and June 2001 by Becky Little, a specialist contractor in earth and lime technologies, and Tom Morton, an Architect specialising in sustainable design. The study comprised of a desk based research, expert consultation, and field visits to earth buildings in Scotland, England, Northern Ireland, Wales, Holland and Germany.

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