CONSTRUCTING EXCELLENCE
in the built environment



demonstration project

The pond has attracted a large amount of fauna and accompanying biodiversity

Project Genesis

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The Genesis Centre is an educational facility in Taunton which demonstrates a variety of sustainable building techniques. The £2.5 million, innovative development integrates cutting edge and contrasting sustainable building techniques with mainstream methods. The centre is self funding and acts as a showcase to promote sustainable construction techniques and materials to the public and the construction industry.

It aims to provide a one stop shop for the industry to learn about sustainable construction techniques, receive CPD training and provide advice. The centre is a powerful learning tool for Somerset College of Arts and Technology students and also provides learning resources and materials for training and education partners in the region. The college was the first in the country to offer a foundation degree in sustainable construction.

Background

Whilst sustainable building systems and technology are advancing rapidly, take-up of new materials and techniques in the construction industry remains slow. Through organisations such as Constructing Excellence South West, Sustainability South West, Ecos Trust (formerly Somerset Trust for Sustainable Development) and the Cornwall Sustainable Building Trust the region has developed a large number of exemplar construction projects. The partners felt there was a need for a focal point for showcasing the viability of sustainable construction both to the industry itself, to the public and to local government planning authorities.

Overall Project Aims

The main medium to long term aims of the project were to embed Sustainable principles through:

- Having an impact on the design of future housing and refurbished buildings
- Training the crafts and professionals, both new to the construction industry and already employed within the industry to build using sustainable principals and local sustainable materials
- Impacting energy use in the South West
- Increasing recycling
- Creating more local businesses and jobs in the industry
- Changing lifestyles to embrace sustainability
- Creating new businesses providing sustainable materials, resources and services for sustainable construction
- Contributing to the reduction in traffic congestion in towns and cities through promoting and educating on sustainable transport

The team were also keen for any lessons learnt through the construction of the centre to be shared and disseminated throughout the industry and through the wider community.

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The Approach

The Genesis Project began as a student assignment carried out by the HNC construction students to provide a new resource for the construction industry to promote and exchange new ideas on sustainable construction. Some excellent designs were developed by the students and, with the help of the Construction Industry Training Board (CITB), a South West Regional Development Agency Grant was eventually won to turn the student project into a reality.

The Genesis project was officially launched in February 2004 at Homes for Good, the South West's first major green building fair. A scale model of the design was unveiled at the fair by Grand Designs TV presenter, Kevin McCloud.

Partnering

Initial project meetings included the Client, Finance Director and Deputy Principal of the college, architect, mechanical and engineering consultants, structural engineers, Ecos Trust and the project managers. As well as this, local experts were brought in to advise on and debate the advantages of the different build materials and techniques. The contractors and facilities management team did not become involved until the designs were quite well developed. It was subsequently felt that earlier involvement of the Facilities Management team could have avoided difficulties encountered during the operational phase of the project.

Design

Building Materials

The building is designed around a central forum space with a series of intersecting pavilions. The externally protruding portion of each of the pavilions is fully finished and weather tight, whilst the internally protruding sections inside the main forum space have their fabric stripped away to reveal and demonstrate the construction. The four building types used in the pavilions consisted of: timber frame insulated with recycled newspaper and clad in green western red cedar; straw bale construction finished with a lime render externally and lime plaster internally; earth construction, including rammed earth and cob techniques; single fired clay block; and steel and glass. The roofs were insulated with recycled cotton denim quilt and roof finishes included EDPM single ply rubber membrane on the main forum building and a variety of green roofs on the pavilions. The use of concrete and its cement content were minimised. The selection of materials was not designed to demonstrate the definitive solution to sustainable building but demonstrate the kind of solutions that are possible.

The overall design of the building was intended to engage with and inspire mainstream industry. As the result of this aim, certain materials have not exhibited their strongest and most efficient properties, eg. the design of the straw bale pavilion was a deliberate attempt to challenge the perceptions of what a straw bale building should look like. As a result, some of the design features are not necessarily best suited to this material. In the case of the earth pavilion, the material is widely documented as providing excellent humidity control in buildings and maintaining stable temperatures. By using this material in a situation where the pavilion is constantly open at one end to the wider building, these properties are partially negated.

The decision to omit skirting boards and door plates in certain areas of the building was taken on the basis of reducing material use and aesthetics. Feedback from the facilities management team has been that this has led to premature wear and tear.

Energy and Water Efficiency

The building's pavilions were designed to be heavily insulated, efficiently heated and naturally ventilated to avoid the need for artificial cooling. Each pavilion is individually controlled to enable the building to be used flexibly and efficiently. To reduce water consumption water efficiency components such as spray taps and waterless urinals were specified. Rainwater harvesting was investigated but due to the low water requirement of the building it was found to be significantly more cost effective to draw water from the mains. Water heating was provided by solar panels and a contribution to electricity is made by photovoltaics. Low energy lighting is specified throughout.

Heating

The building was designed to be heated using biomass boiler. The original thinking was that wood waste from the college workshops could contribute to the fuel supply, but upon investigation quantities were insufficient to interest pellet producers to take the waste away. Fuel is now supplied by a local producer of wood pellet from sawmill waste.

The orientation of the building meant that some of the building materials were not used to their full advantage. For instance, building techniques with high levels of insulation such as straw bales were used on the south facing side which, with a lack of adequate shading on the large areas of glazing, put that pavilion at risk of overheating. These large windows also increase reverberation, reducing the beneficial acoustic properties of the bales. Fired clay block and earth walls have better thermal mass and so would have been more appropriate materials for this pavilion.

In some cases the aesthetic of the building and the technologies conflicted. For instance, the thermostat and controls for the wind catcher technology in the lecture theatre were hidden inside a cupboard which was also used to house the IT cabinet. The heat from the equipment gave a false reading to the thermostat causing the technology to be less effective than it was designed.

In the straw and clay pavilions, there was a potential clash between

the shape and dimensions of the buildings and the materials used to construct their walls. In the case of the straw pavilion the bales had to be cut in order to meet the finished wall height. The pentagonal shaped clay pavilion, uses blocks that, when used with rectangular buildings can reduce waste, construction time and thermal bridging.

The design team originally intended to specify the use of sheep's wool insulation in the ceiling voids of the earth and straw pavilions but to reduce costs it was decided to use Innotherm (recycled cotton insulation) instead. The Innotherm was wider than the ceiling voids and the material had to be cut along its length. This was a labour intensive exercise due to the strength of the material and as a result the team felt that this was probably a false economy.

Key Lessons Learnt: Design stage

- Some building materials are suited to certain parts of the building depending on its orientation. Those with high levels of insulation are more suited to north facing walls whereas materials with high thermal mass are better suited to south facing walls
- Operation of the building should be considered at the design stage to make sure the sustainable technology performs efficiently
- The choice of biomass heating system should be designed to take into account the existing supply chain
- Matching shape and dimension with materials can reduce waste, improve energy performance and increase speed of construction

Construction

As the project was designed to be a showcase, many different and unusual products and systems were specified. Many of the contractors had not worked with the sustainable building materials and systems prior to the project. By the end of the project the site workers and notably the project manager became advocates of the materials and saw the advantages they could bring.

The pioneering nature of the project made it difficult to make accurate cost predictions at the design stage. This meant that value engineering had to be employed as the construction progressed which put pressure on the project timetable and inevitably, the project budget needed to be increased. Further delays were caused when the project's window supplier went out of business having already accepted a deposit from the project.

Timber Frame Pavilion

A lightweight, super-insulated, time-frame structure was chosen to house the office space as it has a rapid heating response which can be ideal for sporadic demand environments. It was off-site pre-engineered, timber-clad and insulated with recycled newspaper.

Earth Pavilion

What is Rammed Earth construction?

Rammed Earth construction uses earth, which has suitable proportions of sand, gravel and clay, compressed within a rigid frame to create a solid wall of earth. It has excellent thermal mass properties and can be locally sourced. It is also a cost effective material as it can sometimes be obtained without charge.

The earth pavilion was designed to demonstrate rammed earth, earth blocks and cob construction. To construct the earth pavilion, local sub soil had to be analysed to ensure it was the correct material. Once the correct earth was found, specialists were employed to construct the walls. The high thermal capacity of this building material can not be taken into account when using the current Part L assessment methodology. The commonly adopted strategy is to increase the thickness of the walls and compensate for their high U-value by increasing the insulation levels in other elements such as the floor and the roof space. The limitations this strategy would eventually bring about, led the design team to make the decision to externally insulate the earth walls.

Key Lessons Learnt: Earth Pavilion

- The team felt that using specialist contractors to construct the rammed earth and mass cob walls made a significant contribution to the overall project costs. They felt that, once the correct soil has been identified and if expert guidance was on hand, construction could be completed by non specialists.

Clay Block Pavilion

What is clay block construction?

Using clay blocks as a construction material can have many advantages as they combine structure, external envelope, moisture protection and insulation. The thin horizontal joints and no vertical joints can reduce the mortar requirement by up to 40%. The blocks are currently used in Europe but are not regularly seen in Britain.

The third pavilion was constructed using "Ziegel blocks", clay blocks mixed with sawdust and fired in a kiln. The blocks are thin joint and can be fixed together using glue with no vertical joints. The blocks are best utilised as a whole wall system and have a high U-value.

Key Lessons Learnt: Clay Block Pavilion

- Using clay blocks for curved walls can put stress on the joints putting them at risk of opening up. The clay blocks perform best when used in straight walls.

Operation

One of the key lessons learnt from this project is the importance of including the facilities management team at the earliest possible stage. In hindsight, the project hand over could have been managed over a longer period of time with training provided for the site staff on how to operate the new systems and technologies. Information sheets provided post handover were not seen by the FM team as sufficient and the lack of training caused problems with the maintenance of the building. The lack of knowledge of the specialist systems within the maintenance team also led to issues over fuel quality for the biomass boiler that, at times, caused excessive quantities of fuel to be burnt and the boiler to go out.

Further maintenance issues arose when the outside of the earth pavilion was vandalised. Repairs were made to the render using unsuitable materials and unsuitable paint which could affect the overall performance of the building.

Renewable Energy Technologies

Water heating was designed to be provided by a solar thermal system. The centre was not predicted to have a high level of water use and an original analysis suggested that 60 solar thermal tubes would be required for this building. However, once installed the system persistently lost pressure and frequently broke down. After a year, a report commissioned to investigate the problem with the system, concluded that only 20 to 30 tubes were actually needed for a building with this level of water usage and small, 210 litre, tank size.

Heating for the building was provided by a biomass boiler which had to be manually lit which was impractical for the college. It also meant that the boiler needed to be kept running over the weekend to ensure the building would be warm by Monday morning. As well as this the biomass boiler fire prevention equipment malfunctioned resulting in a fire within the fuel hopper causing it to be out of action for a prolonged period. During this time, due to the lack of any back up heating, electric heaters had to be used.

Water Conservation

Water on the development is managed through a sustainable urban drainage system (SUDs) which has performed well so far. The pond, which forms an integral part of the system has attracted a large amount of fauna and accompanying biodiversity. However, the maintenance team are concerned that inappropriate plants in the reed beds may adversely affect the drainage system. For future projects the provision of a maintenance manual for the SUDs has been identified as a learning point from this project.

Other water saving features have also proved challenging for maintenance staff such as the air flush urinals which meant that conventional cleaning methods such as urinal blocks were not appropriate. This was communicated to the cleaning staff who have experienced no further problems.

Key Lessons: Operation

- Integration of estates and facilities management team into the project at an early stage could have made the handover more smooth and reduced the risk of problems during the operational phase
- The production of training and/or instruction manuals would have ensured that the building systems were properly managed

Social Sustainability

The building is sited on a college campus and originally it was intended to close the site for two days per month to allow for site visits and courses to be run. Delays in the project timetable however, meant that the site could not be closed. There was also concern that involving the students in the build could put the final build quality at risk. Despite this, the project manager was very open to ad hoc requests for site visits and this allowed for around 1200 people to be taken round the site during the construction phase.

Learning Dissemination

The learning from the Genesis project will be taken forward to a large scale regeneration scheme- Project Taunton. The Genesis team have been involved in the development of the Taunton Protocol which requires developers, builders and professionals involved in the design and construction of the new developments to commit to 10 principles related to low carbon development, environmental responsibility, employment and training, design and wellbeing. The team from the Genesis project are putting together technical sheets which Taunton Deane Borough Council would like to send out to those applying for planning permission. Project Taunton will include a Skills Academy where training, developed in the Genesis centre, will be delivered.

As a result of the Genesis Centre, Somerset County Council has chosen to use timber frame, rammed earth and straw bale construction on a forthcoming Park and Ride scheme.

"We have built a very modern building which I hope will change people's perception of sustainable construction. Prior to this project I thought the use of these types of sustainable materials would be difficult to integrate into mainstream construction but this building is proof that they can. I now believe that these materials can and should be used."

Mark Preston

D C Russell, Main contractor

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