Eco House

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Introduction

What is Sustainable Development (Eco - Efficiency)?

"The delivery of competitively priced goods and services which satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity,"

World Business Council for Sustainable Development.

Why Sustainable?

- Global warning – UK plans to deliver its Kyoto target to cut its greenhouse gas emission by 12.5 % and move towards its domestic goal to cut carbon dioxide emissions by 20 % below 1990 levels by 2010.
- Health and safety – human's health at risk due to pollution and climate changes.

What is an Eco House?

Eco House is a sustainable development, which is designed to make use of the surrounding environment with minimum detrimental effects to meet the client needs.

Project Aim

To design an eco friendly accommodation, at an existing university car park close to a local school, based on current and emerging technologies, which is economically, environmentally and socially acceptable.

Design Concepts

In applying sustainable development concepts to the built environment, building design and construction, the core considerations are:

- **Social Dimension**

  To create a built environment that meets student needs: Provides comfortable accommodation, accessible services and leisure facilities.
- **Economic Dimension**

  To create an affordable student accommodation with high efficiency and low maintenance cost for the client.
- **Environmental Dimension**

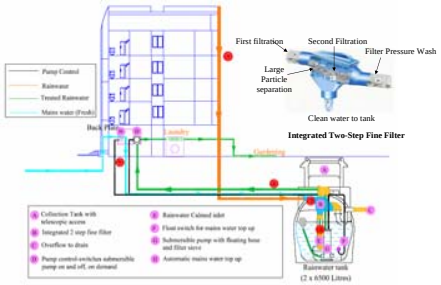
  To use materials and adopt forms of design that use resources efficiently, minimise waste and pollution, protect and enhance biodiversity and create a healthy environment.

System Design

Features of the Water Systems

- Low energy consumption
- Low maintenance – self-cleaning and system check
- Grey Water Quality conform with the E.U. Directive 76/160/EWG for Recreational
- Automatic mains water top up

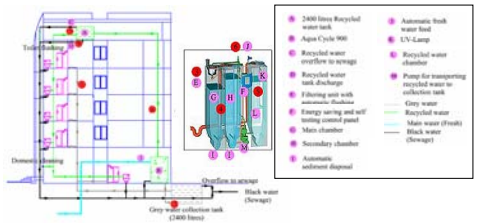
Rainwater System



Rainwater System Operation Process

1. Rainwater falling on the property roof flows into gutters to the rainwater tanks.
2. Initial filtration takes place to remove debris.
3. Subsequently, biological treatment to breakdown the contaminants (supply oxygen).
4. Transport the treated rainwater to the demand points (Laundry and Garden).
5. When the tank level is low, an in tank flow switch opens the mains water solenoid valve, which allows mains water flow into the tank.

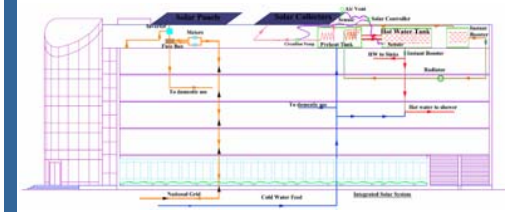
Grey Water System



Grey Water System Operation Process:

1. Grey water from shower flows into the grey water collection tank.
2. Grey water is subsequently transported to the Aqua Cycle 900 for treatment.
3. **First stage**: *Pre-filtration* to remove particles likes hair.
4. **Second stage**: *Two fold Biological treatment* to breakdown contaminants such as hydrocarbons and organic compounds by feeding oxygen into the main and secondary chambers.
5. **Final stage**: *Disinfections* using UV-light lamp to kill microbiological or bacterial activity.
6. Recycled water is then transported to recycled water tank.
7. Supply recycled water to demand points (Toilet flushing and domestic cleaning purposes).
8. The recycled service tank will be drained and refilled every 3 days (Programmed control system) due to the health and safety issue.

Solar System



Grid Connected System Operation Process

a. Daylight hit the PV and is converted to energy.
b. Electricity from the panels is inverted through an inverter.
c. For safety reason, the system is connected to the grid via fuse box.
a. Spare electricity flows out to the grid or take back outside daylight hours.

Solar Panel Facts:

i. Deliver 42.08 MWh renewable energy per annum.
ii. Annual system energy saving £ 3824
iii. Reduce 21000 kgCO2/yr

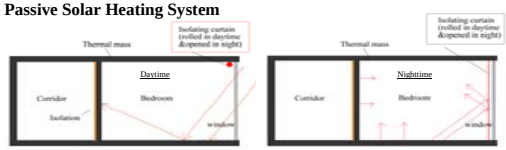
Drainback System Operation Process

1. Distilled water is circulated by the pump from the preheated tank in a closed loop.
2. Cold water is heated in a preheated tank, then flows into the hot water storage tank (3000 litres for 51 students per day)
3. Hot water from the storage tank is distributed to the demand points.
4. Water in radiators flows through preheated tank and is heated up before transferring heat across the accommodation.
5. Instant booster is only used when the water temperature failed to reach the requirement.

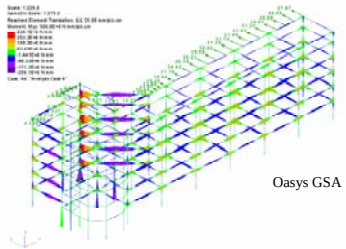
Solar Collector Facts:

i. Provide 100% of hot water in summer and 43% in winter.
ii. Deliver 41910 kWh renewable energy per annum.
iii. Annual system saving is £ 3034.
iv. Reduce 20340 kgCO2/yr

Passive Solar Heating System

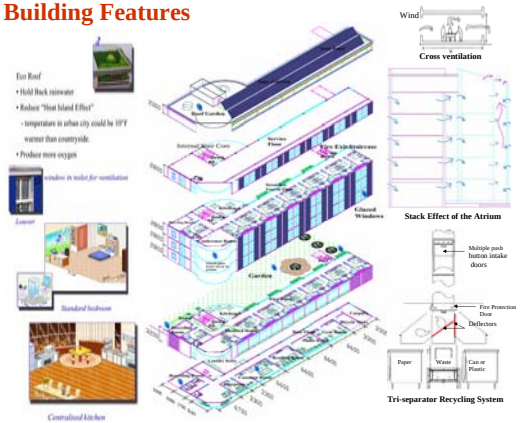


Building Structure Analyse



- The superstructure of the building is reinforced concrete frame with 150 mm thick precast hollow core floors.
- To maximise the headroom, beams are going to be precast to the soffit of the slabs and fill to the finish floor level.
- The combined effect of wind and snow had been analysed with a computer model.
- The size of the beams and columns are calculated. Typically beams are 300×430 mm and columns are 300×450 mm.
- The beam with the maximum moment is in the kitchen where the span is the longest. The depth of these beam are increased to 530 mm.
- The maximum resolved displacement of the building is 32 mm.

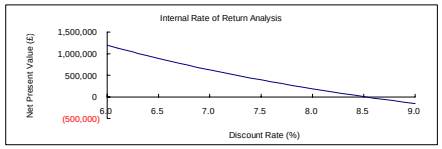
Building Features



1. Intelligent recycling system is installed.
2. Multiple facilities to provide relaxation to students.
3. View of Bristol is available from bedrooms through large glazed window.
4. Friendly design for the disabled people.
5. Back garden is designed to minimise the visual impact to the nearby school.
6. Louver for shading sunlight.
7. Good natural ventilation.
8. Encourage green with window boxes and eco roof.
9. The accommodation is able to accommodate 51 students.
10. The floor area for each level is 416.4 m^2.

Financial Assessment

- A 50 year life cycle cost has been studied. The future trends in the maintenance cost, system efficiency, electricity and water charges have been considered in the calculations.
- The building itself cost £2,068,900, with the outlay of £328,600 for the water and energy systems, the whole project cost £2,397,500 and can be paid back in 13.5 years from the renting revenue.
- The project has a Net Present Value of 1.2 million pounds at 6 % discount rate.
- The Internal Rate of Return is 8.5 %. Comparing with the Treasury's 6 % discount rate for construction project, this project is worthwhile and profitable.



Visual Model and 3D Max Model

Visual Model

South view of accommodation

North view of accommodation

Conclusions

- An eco friendly student accommodation has been designed with an aesthetic and modern looking.
- The building can provide most of its own energy required by utilising the renewable solar energy and reducing energy loss in heating.
- The water reclaiming and recycling system has been designed to achieve an optimum use of the rainwater and grey water.
- Careful consideration has been taken in selecting types of material to minimize waste and pollution.
- The building structure has been designed and intensively analysed with the aid of computer modelling.
- A high efficiency, low maintenance and affordable accommodation that satisfies the needs of the clients with minimum damage to the environment has been achieved.
- Estimation of building's performance:
  - Water consumption – reduce by 30 %
  - CO_2 emission – reduce 41340 kg/yr
  - Heat Loss – reduce 636 kW loss per year
  - Plants over the eco roof are able to supply enough oxygen for 87 persons and reduce the noise levels in the top level.

Acknowledgements

Special thanks to the project supervisors, Dr. John Davis and Dr. Dawei Han, who have offered endless encouragement and support throughout the project. Moreover, we would like to thank Dr. Adam Crewe, Dr. Erdin Ibraim, Mr. David Nash, and Dr. Sally Heslop for providing valuable suggestion during the designing process.