Renewable materials in construction

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UNIVERSITY OF BATH

BRE Centre for Innovative Construction Materials

- Partnership between University of Bath and Building Research Establishment
- 30 staff and PG students
- Areas of work:
  - Advanced composites
  - Low carbon materials
  - Reuse of materials

Current research work

- **Innovative concrete structures**
  - FRP strengthening and reinforcement
- **Structural masonry**
  - Lime mortars
- **Timber materials and engineering**
  - Engineered timber products; Traditional carpentry; Timber concrete composites
- **Natural fibre composites**
- **Low carbon materials**
  - Earthen architecture; Hemp-lime; Straw bale
- **Geotechnical engineering**
  - Dry-stone wall masonry

Research motivations

- Improved performance
- Carbon
- Waste
- Training
- Commercial development
- Dissemination and uptake

Arguments for renewable materials

CIRIA Report (2004) Crops in construction handbook
DEFRA (2006) Creating value from renewable materials

- Reduced reliance on non-renewable resources (quarried mineral products; fossil fuel products; glass; metals)
- Reduced embodied carbon content
- Reduced waste
- Socio-economic benefits
- Improved construction performance
  - Biodegradable geotextiles
  - Natural paints (air borne pollutants)
  - Insulation materials (improved performance when damp)
  - Compost materials on end use
- Local processing/manufacturing
- Healthier buildings
- Enhance biodiversity

Crop based materials

- Insulation
  - sheep's wool
  - hemp
  - flax
- Light structural walls
  - straw bale
  - straw-clay
  - hemp-lime
- Paints and finishes
- Wall and floor coverings
- Geotextiles
- Thatch
- Timber and timber products

Renewable materials research

- Hemp-lime composites
- Pre-fabricated straw bale panels
- Natural fibre composites

Hemp-lime construction

- A composite mix of hemp particles (shiv), hydraulic lime and, sometimes, sand
- Hemp particles are woody plant stem by-product left over from hemp fibre production. Lightweight filler
- Main use in-situ built solid wall infill in timber frame buildings. Also used for floors and ceilings
- Lime:
  - Binder
  - Preservative
  - Fire protection
- Mix proportions: 1 part hemp: 2 parts lime (by mass)
- Carbon sequestration: 110 kg/m^3
  - Sequestrates 12-20 kgCO_2/m^2 (300 mm thick wall)
  - Masonry cavity wall emits 100 kgCO_2/m^2
  - Carbon saving 12 - 15 tonnes per home

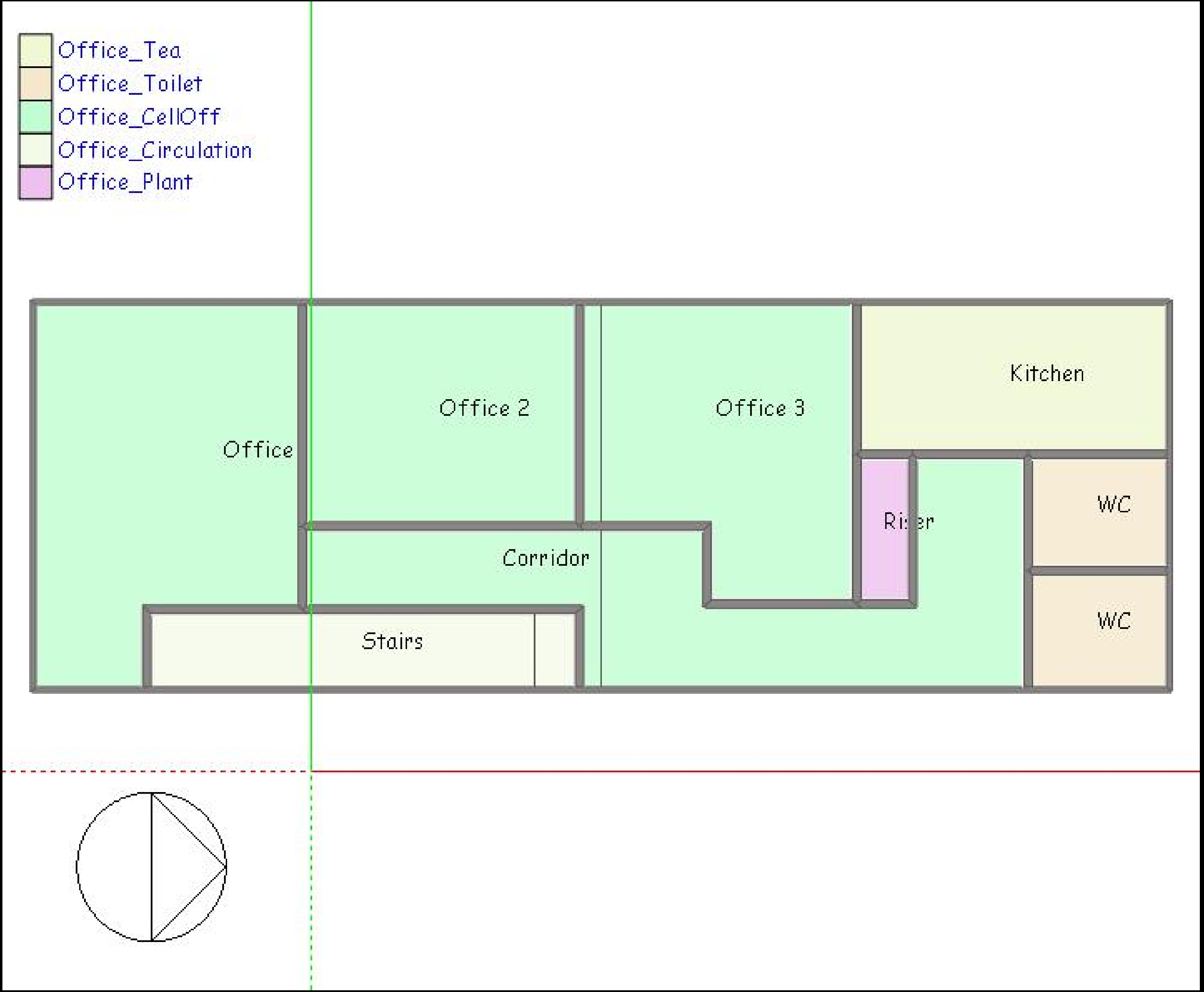
Hemp production

- 1 hectare (UK) produces 8-10 tonnes of hemp – sufficient to build one house
- It takes around 14 weeks to grow from seed to 4m high
- 60% of the plant consists of shiv


CLAAS
JAGUAR

Characteritics of hemp-lime

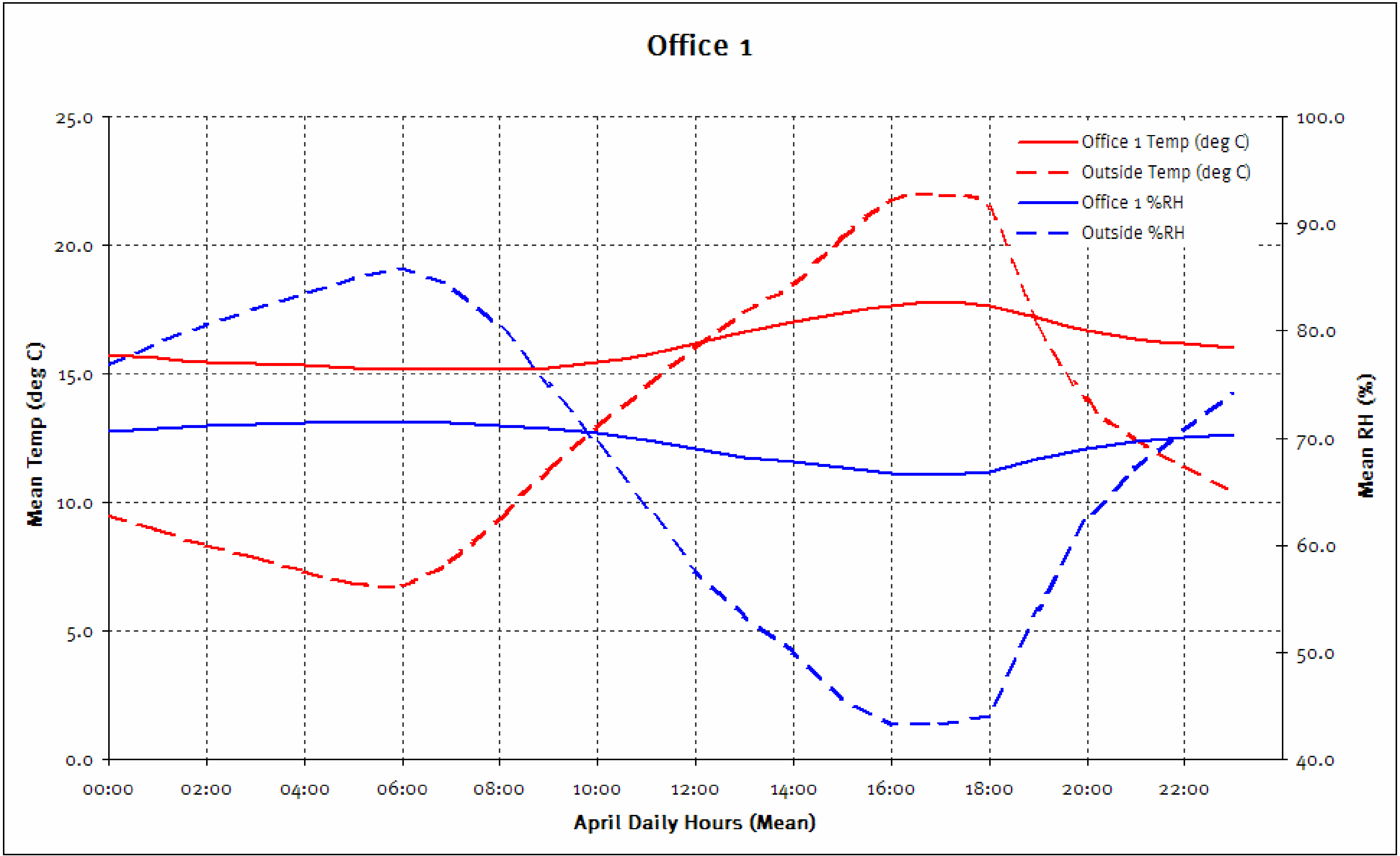
- Low density
- High thermal insulation
- High sound insulation
- High thermal inertia
- Good vapour permeability
- Creates comfortable healthy buildings
- Fire and pest resistant
- Fast and economic construction



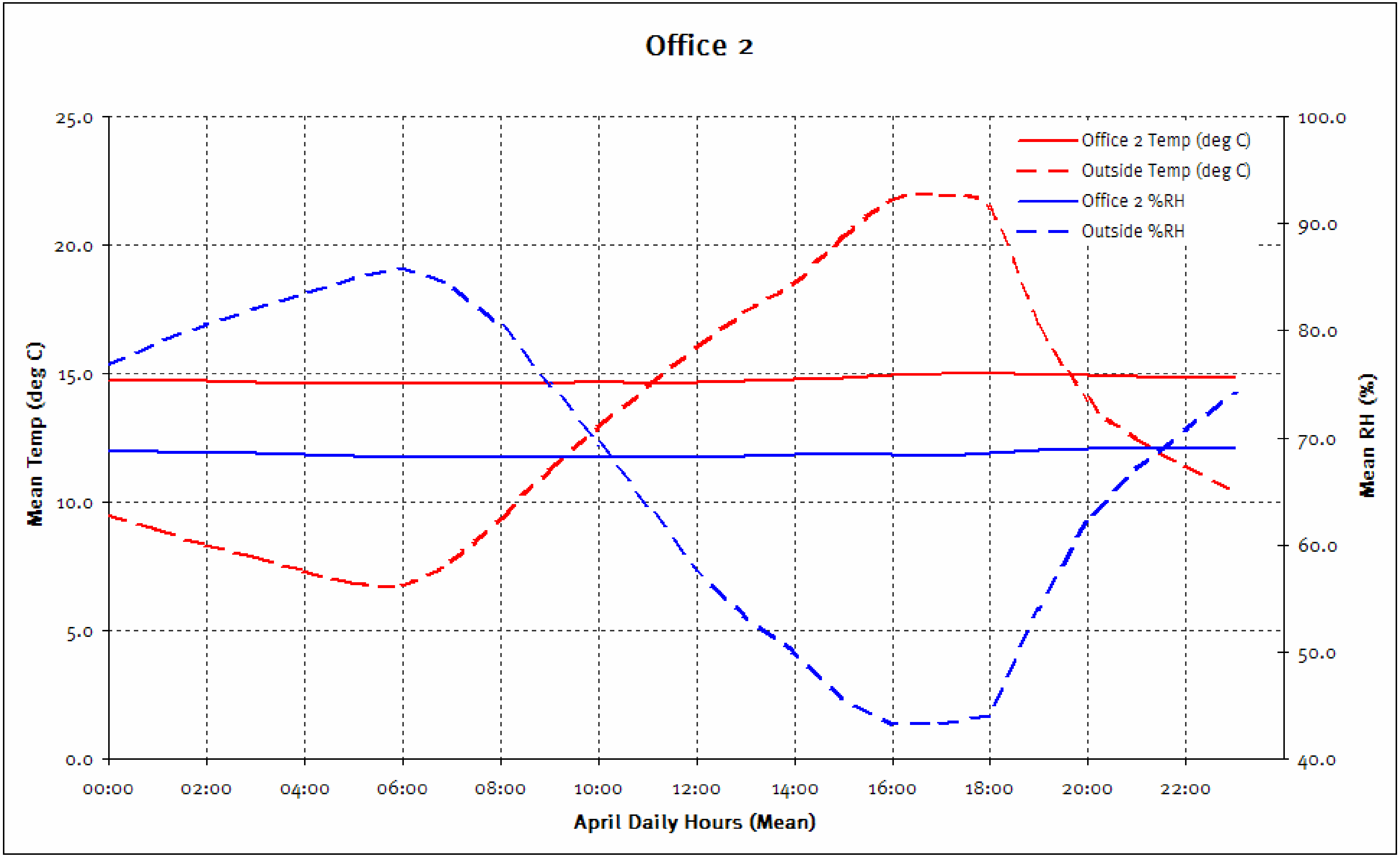
Office_Tea
Office_Toilet
Office_CellOff
Office_Circulation
Office_Plant
Kitchen
Office 2
Office 3
Office
WC
Riser
Corridor
WC
Stairs

Monitoring April 2007

- The first floor offices are being monitored for temperature and relative humidity whilst empty
- 500mm Hemcrete® walls to the south and west elevations as part of the office refurbishment
- North wall is original brick and block
- East wall is the internal concrete block wall to the warehouse
- The first floor ceiling is 220mm thick Hemcrete®



Office 1
Mean Temp (deg C)
Mean RH (%)
April Daily Hours (Mean)
Office 1 Temp (deg C)
Outside Temp (deg C)
Office 1 %RH
Outside %RH
25.0
20.0
15.0
10.0
5.0
0.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00



Office 2
25.0
20.0
15.0
10.0
5.0
0.0
Mean Temp (deg C)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
Mean RH (%)
Office 2 Temp (deg C)
Outside Temp (deg C)
Office 2 %RH
Outside %RH
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
April Daily Hours (Mean)

ModCell


MITSUBISHI


DANGER


Visability
Clothing
Be Worn


RAMP
ONE WAY


WLL 3000 Kg

Barriers to crop material uptake

- Cost
- Industry awareness
- Lack of technical information on material performance
- Supply concerns
  - Variable crop yields
  - Seasonal crop availability
  - Uncertainty over future costs (subsidy levels)
- Need for training in material use

Research needs

- Development of material performance understanding
  - Mechanical properties
  - Durability
  - Environmental properties
- Robust details
- Hybrid systems
- Supply chain issues
- Models/guidance for environmental performance
- Life Cycle Analysis/Life Cycle Costing
- Building performance tests - demonstration buildings

Thank you