Environmental Resource Centre, Ebbw Vale

Monitoring Report

August 2010

Prepared by the Design Research Unit Wales

The Welsh School of Architecture

For Wood Knowledge Wales

druw wsa
Design Research Unit Wales

contents

1.0 practice profile

Design Research Unit Wales

The Centre for Research in the Built Environment is recognised as a Centre for Excellence by the Welsh Development Agency (CETIC) and has particular expertise in sustainable design and construction from city scale to materials and components.

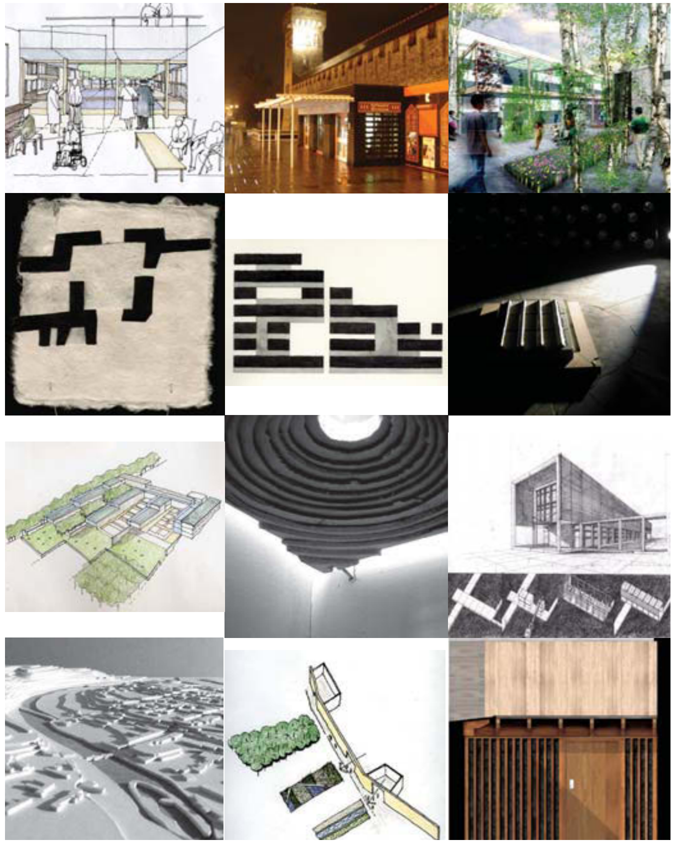
The Design Research Unit Wales was set up in 1997 to concentrate on architectural, urban design and landscape projects from the position of research. The Unit undertakes projects, often in collaboration with other specialists, that provide the opportunity for the development of design studies based on research or as research in their own right.

The common goal in the work of the Design Research Unit Wales to date has been to found the activities of the Design Studio on a sound research-based approach. As such, projects are shaped through rigorous and critical analysis of all parameters shaping the conceptualisation, development and solution of the project.

The design and research projects are pursued through collective and collaborative endeavour underpinned by the considerable resources of the Centre for Research in the Built Environment, The Welsh School of Architecture and Cardiff University.

Resources

DRUw validates and tests designs through the use of the School's environmental laboratory where daylight design, solar and wind studies are conducted using physical models. As well as the use of the environmental laboratory another key resource is the Architecture Library of the Welsh School of Architecture. This is the most comprehensive architectural and planning library in the Principality and contains historical and theoretical texts on architecture, urbanism and landscape, plus an extensive collection of monographs on national and international practice.



2.0 introduction

The Environmental Resource Centre (ERC) at the The Works in Ebbw Vale has been designed by the Design Research Unit Wales (DRU-w) for Blaenau Gwent County Borough Council and is the first project to use the award winning Ty Unnos Sitka Spruce construction system. The sustainable building combines low cost Welsh timber, high levels of insulation and a state of the art heating and ventilation system to provide an environmentally friendly and innovative building.

The ERC is located on an ecologically rich site next to the Pumphouse cooling ponds, which have become a haven for wildlife since the closure of the steelworks. The centre will provide educational facilities to allow local school children and the community to explore the heritage and ecology of the former steelworks site.

The centre will be run by Gwent Wildlife Trust and will provide:

- Wildlife courses for people of all ages
- Specialist courses for school children linked to the foundation phase and key stages
- A focal point and meeting place for community environmental activities and conservation volunteering.

The Ebbw Vale ERC Monitoring Report for Wood Knowledge Wales is intended as a reflection on the first realised application of the Ty Unnos construction project. The report will assess the performance of the system against a number of learning objectives in order to propose future development opportunities.

2.0 project team

Client	Blaenau Gwent County Borough Council
End user	Gwent Wildlife Trust
Architect	Design Research Unit Wales (DRU-w)
Structural engineers	Burroughs
M&E Engineers	Halcrow Yolles
Planning Consultants	Savills
Quantity Surveyor	Blaenau Gwent CBC
CDM Co-ordinator	Gardiner Theobold
Main contractor	G Adams Construction
Ty Unnos specialist	Cowley Timberwork
Masterplan Architects	Alan Baxter Associates

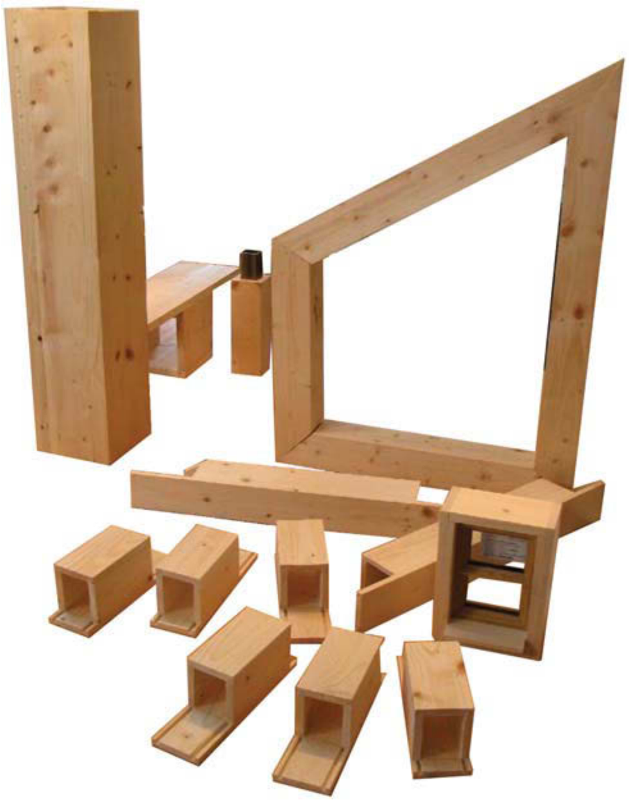
3.0 learning objectives

Ty Unnos is a collaborative research and development project to employ the use of Sitka Spruce in the design and construction of affordable, sustainable rural construction in Wales. The project team proposed the following objectives;

1. To exploit a high volume, low value crop- Sitka Spruce, to add value and encourage investment in welsh forestry management;
2. Use low tech manufacturing to re-engineer local resources to make a 'universal' construction component for use in the structure and fabric of housing;
3. To test the componentry structurally;
4. To gain research funding to continue research and development for certification and delivery into the construction industry;
5. To test the manufacturing potential of the componentry;
6. To prototype the system in a single demonstration dwelling integrating an extended range of welsh products developed by Coed Cymru;
7. To analyse the economic potential of the system through a number of proto-type building projects;
8. If viable, to partner with a strategic developer to begin a site of approximately 5 dwellings of different household sizes.

Through the presentation of a Feasibility Study and continued research, Steps 1- 4 were accomplished in a very short time frame. In order to develop the research project further the design team identified a number of potential proto-type buildings which could employ the system and provide real construction dynamics to enable us to meet these learning objectives. The Environmental Resource Classroom provided the first opportunity to test componentry, in this case a portalised box section frame with infil SIPS panel, and provide the following learning objectives;

1. Economic evaluation_ assessment of affordability under a constrained budget
2. Authority approvals_ design and construction detailing impact in response to Planning and Building Regulation criteria
3. Structural testing_ fully calculate and test structural performance of Ty Unnos portal frame
4. Construction and buildability_ constrained programme will test the buildability of the construction system, and limited site puts greater emphasis on off-site manufacturing
5. Finishes_ low-cost, durable and robust finishes need to be employed internal and externally.



4.0 planning

In July 2007, The Works master plan produced by Alan Baxter Associates recieved outline planning permission for the £300 million pound redevelopment of the former Ebbw Vale Steelworks site including new community facilities, a hospital, learning campus and rail hub, and 720 new homes and offices. Development Area 2E of the masterplan identified an area of landscaping and redevelopment of former drainage ponds adjacent to the former steelworks pumphouse for the provision of a temporary classroom building for Gwent Wildlife Trust and associated landscape works. The building named Environmental Resource Centre was programmed for construction in Phase 2E (2010-2012) of The Works Master plan.

Following a number of public exhibits of the Ty Unnos construction system, Blaenau Gwent approached the Design Research Unit Wales to consider the use of the Ty Unnos system for the immediate construction of the ERC. The project was identified by the Client Blaenau Gwent as an opportunity to provide immediate community and education benefits on the steelworks site and, as one of the first projects expected for completion, to set a precedent for innovation and sustainable development that would typify The Works agenda for sourcing local skills, products and resources.

- It was proposed that the ERC would be brought forward into Phase 1 of the masterplan (2008-2010), with expected commencement on site by March 2008, and considered as a permanent building proposal.
- All programmed projects under The Works Master Plan that adhered to an agreed design code, and the master plan programme, would be the subject of a reserved matters application covering layout, appearance, scale, access and landscaping.
- Following extensive negotiations for over four months between The Works delivery team, planning consultants Savills, and the Blaenau Gwent Council planning authority the proposal it was agreed that the project would be brought forward to Phase 1 following the submission of a full planning application.

As a stipulation of the Works Masterplan, all projects to be undertaken on the site had to be submitted to the Design Commission for Wales for comment. The proposal for the Environmental Resource Classroom including landscape plans prepared by Halcrow were submitted for planning approval in October 2008 prior to its consideration by the Design Commission for Wales at the October Review Panel.

Comments from Design Commission

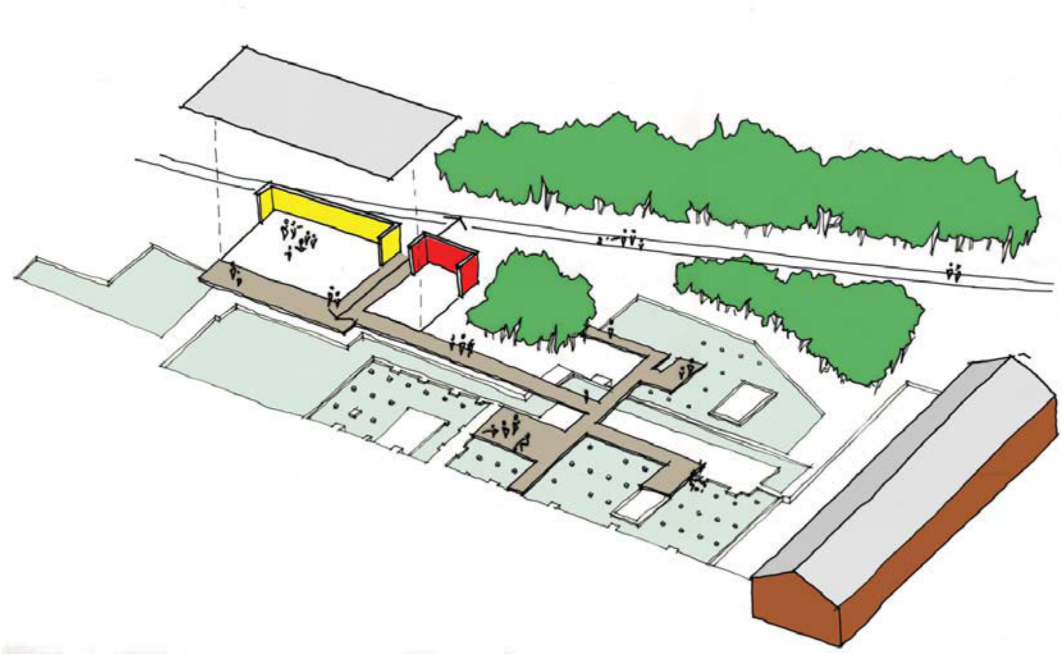
5.0 site

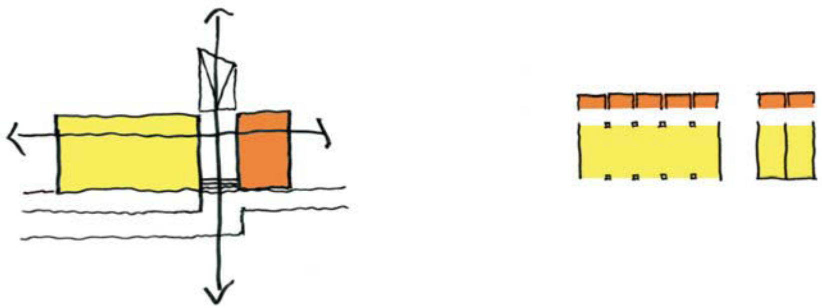
Site

The site is located on the East side of the former steelworks site accessed from Steel Works Road. The former steelworks pumphouse site is an area of derelict constructions including the former pumphouse, a linear red brick building, and a series of large concrete formed filtration tanks. These tanks were used to filter water from the steelworks site before returning it to the River Ebbw. Since the site's decommissioning the undisturbed environment of the pumphouse's filtration tanks have become a haven for a wide variety of wildlife. The existing ERC area contains over 100 plant species together with amphibians, reptiles and birds, and has therefore been identified as an area of high ecological value in the changing face of the steelwroks.

To the east of the site, the ground rises steeply towards Steelworks Road, whilst to the west the formed plateau of the former steelworks rises above the site and the proposed PDR corridor. A footpath runs along the eastern edge of the site following the line of the former rail link, which will be used for access to the building.

6.0 design





Siting and geometry

A simple building form responds to the geometric filtration tanks.

Zoning

The building is zoned by two key axes:

The first axis links the pathway through the building to the boardwalk. This separates the classroom from the service block and addresses the level change between the path and the boardwalk.

The second axis separates a service zone along the eastern edge of the building from inhabitable space alongside the ponds and boardwalk. The service zone is created from prefabricated storage units which will contain wet services and storage, while the inhabitable zone has exposed timber beams and columns expressing its post and beam construction system.

Materials

The two blocks are tied together by an oversailing sheet metal roof. Beneath this the two blocks are clad differently in semi-industrial materials to reflect the industrial heritage of the site. The classroom is clad in charred vertical timber and the service block in metal mesh.

Colour, murals and cladding

Layered facades aim ot create a play of colour and depth. The building appears either brightly coloured or black depending on the viewpoit, while from a distance layering of the facades makes the building shimmer.

The building is clad in black metal panels. Brightly coloured murals across the metal panels will illustrate wildlife as super-graphics, merging with and enhancing the surrounding natural landscaping. Large scale illustrations of plants and animals will be applied across the building to graphically demonstrate its function.

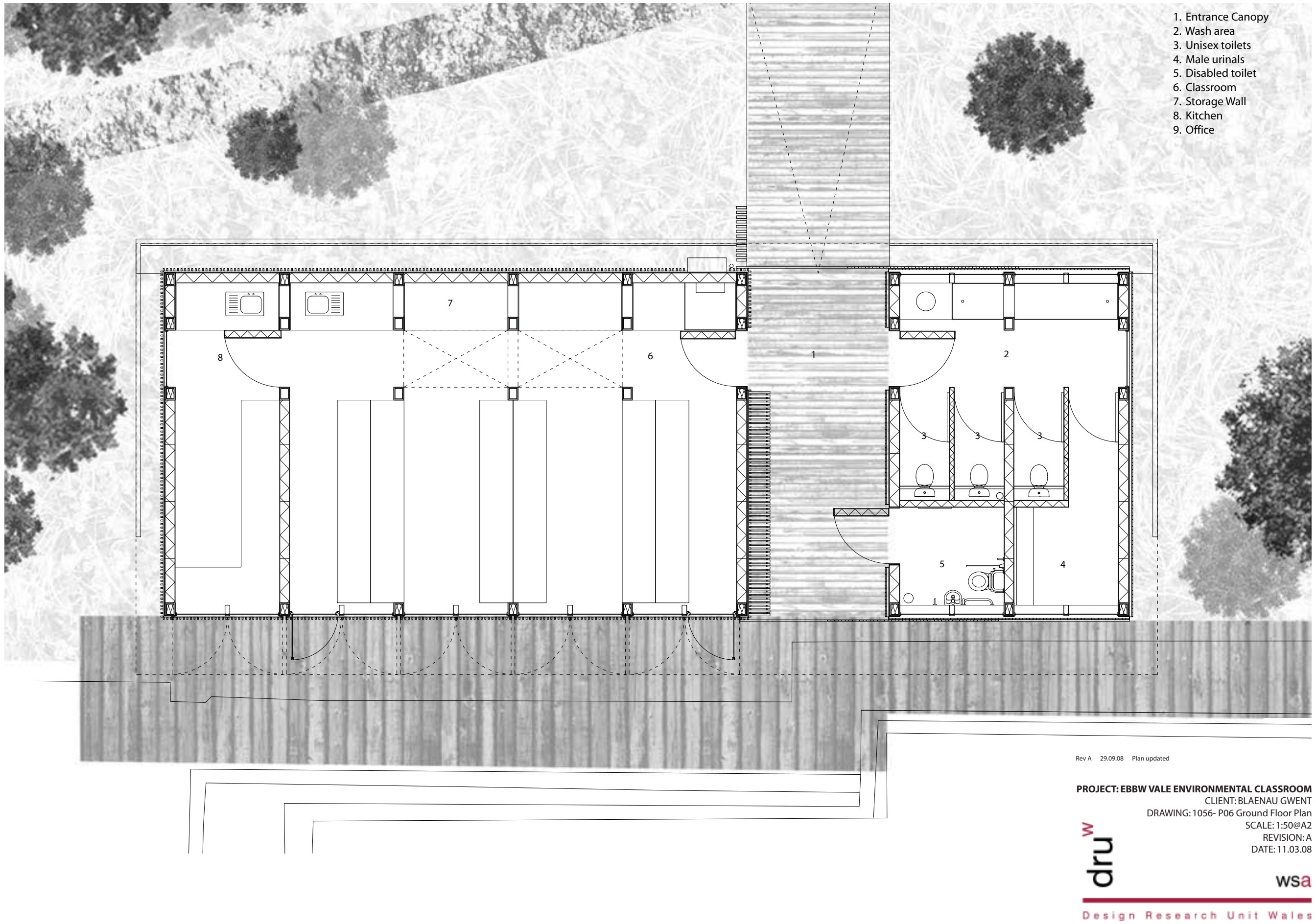
Claddings will be applied over the murals and panels. These aim to obscure the colour and murals from certain angles and reveal it when viewed from elsewhere. The classroom is clad in charred vertical timber battens, while the toilet block is clad in metal mesh.

General Arrangement

Arranged over 140 square metres the building consists of a classroom and office to the north and a WC block to the south. An oversailing lightweight roof connects the blocks across a wide entrance deck. Protected by grillage security screes, the entrance deck provides a protected gathering space where large groups can remove their muddy boots, sat on the intergrated timber bench.

Along the eastern edge of the building, flanking the access path, is a storage wall accommodating cupbard units, sinks and M&E services. To the west the classroom opens up to the boardwalk and drainage ponds through full height windows protected from excessive solar gains and troublesome youths by opening timber shutters.

The interior finishes to the classroom and toilets draws on it's industrial context for inspiration. A hardwearing industrial aesthetic is embraced with exposed surface fixed galvanised steel services and light fittings, stainless steel bathroom fixtures including a formed stainless steel communal trough sink, and exposed surfaces of Birch plywood offset against a charcoal natural rubber floor.



7.0 sustainability

The ERC is designed to achieve a 60% reduction in carbon dioxide emissions. This is achieved through the design of a building which uses sunlight, natural ventilation and low energy technologies.

Ventilation strategy

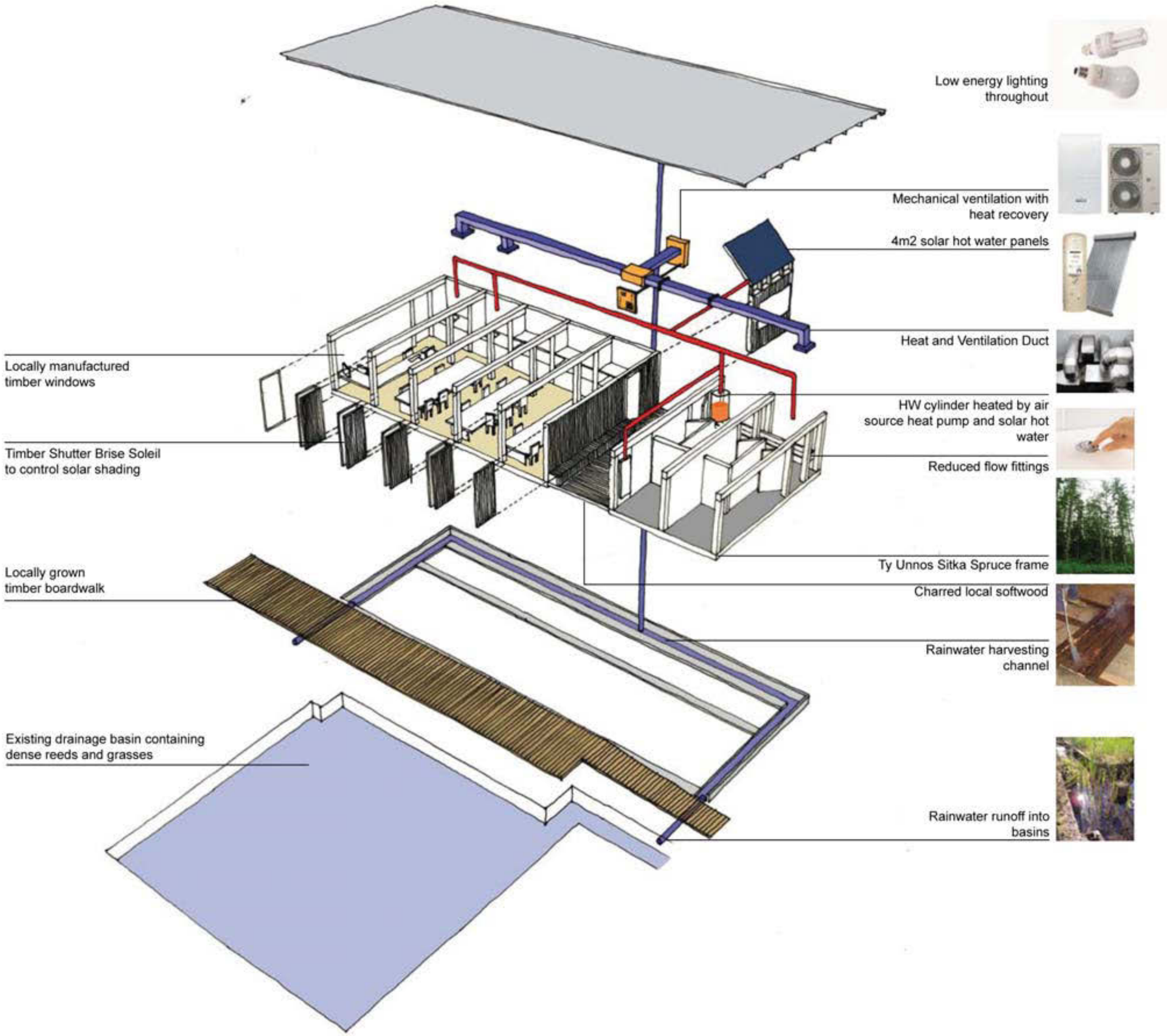
The building uses a natural ventilation strategy. Trickle vents in full height windows provide background ventilation, while these can be opened to provide additional ventilation. An air to air heat exchanger provides warmed air during the winter and additional ventilation during the summer.

Solar strategy

The building is designed to be naturally lit throughout the year. West facing full height openings ensure good lighting conditions to the classroom. This is supplemented by rooflights towards the rear of the building. An oversailing roof prevents overheating by reducing solar gain during the summer months. Shutters over the windows provide additional brise soleil.

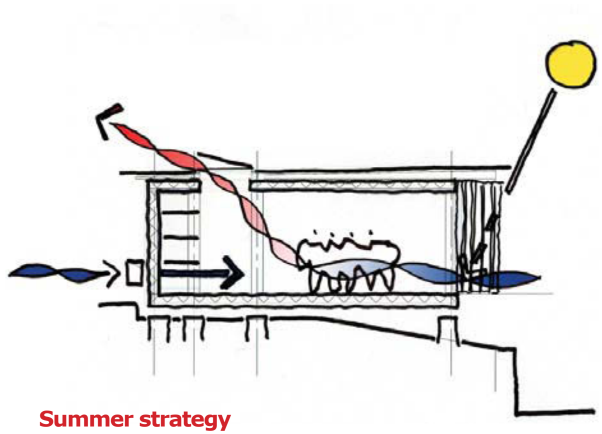
Energy strategy

An air source heat pump provides mechanical ventilation to the building. This is supplemented by a solar hot water array mounted alongside the entrance to the building.

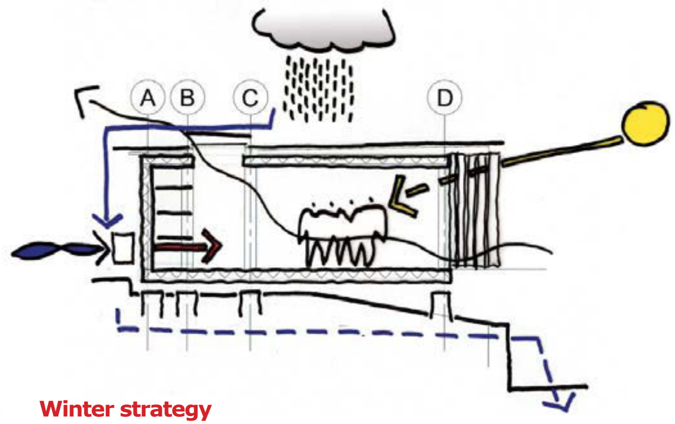


Sustainable development

The primary objective of the Ty Unnos research project is the development of a sustainable construction system which gives added to value to locally sourced sustainable materials. The proposed additions to the Centre will make use of a significant quantity of locally sourced softwood which rarely has value in the construction industry, using it for both structure and cladding. Where possible other construction components such as windows will also be sourced from local sustainable sources and manufacturers.



Summer strategy



Winter strategy

Summer strategy
1 Oversaling roof and brise soleil cut direct solar gains
2 Cool air enters building through trickle vents or open windows
3 Warm air exits through the skylights
4 Additional cool air pumped into building

Winter strategy
1 Low winter sun warms classroom
2 Background ventilation through trickle vents
3 Heat exchanger warms air entering the building
4 Water run off harvested and returned to ponds

8.0 specification

Sub Structure
700X1600mm deep trench fill foundations
203X203mm Continuous Rolled Steel Section sub frame
Pre-cast concrete drainage channel

Structure
TY UNNOS BOX FRAME
270 X 210mm Sitka Spruce laminated box section portalised frame infiled with sheep's wool insulation

TYPICAL FLOOR CONSTRUCTION
Ventilated suspended SIPS Panel of 15mm Spruce Plywood, 195mm Platinum EPS Core, 15mm Spruce Plywood
Linoleum/ Natural rubber Floor Finish

TYPICAL WALL CONSTRUCTION TYPE 1- Classroom
SIPS Panel of 12mm Birch Plywood Lacquered, 195mm Platinum EPS Core, 15mm Spruce Plywood
Resistrix EPDM Membrane
4mm composite steel sheet with applied printed murals- yellow
50X25mm Charred Timber rainscreen @ 75mm centres

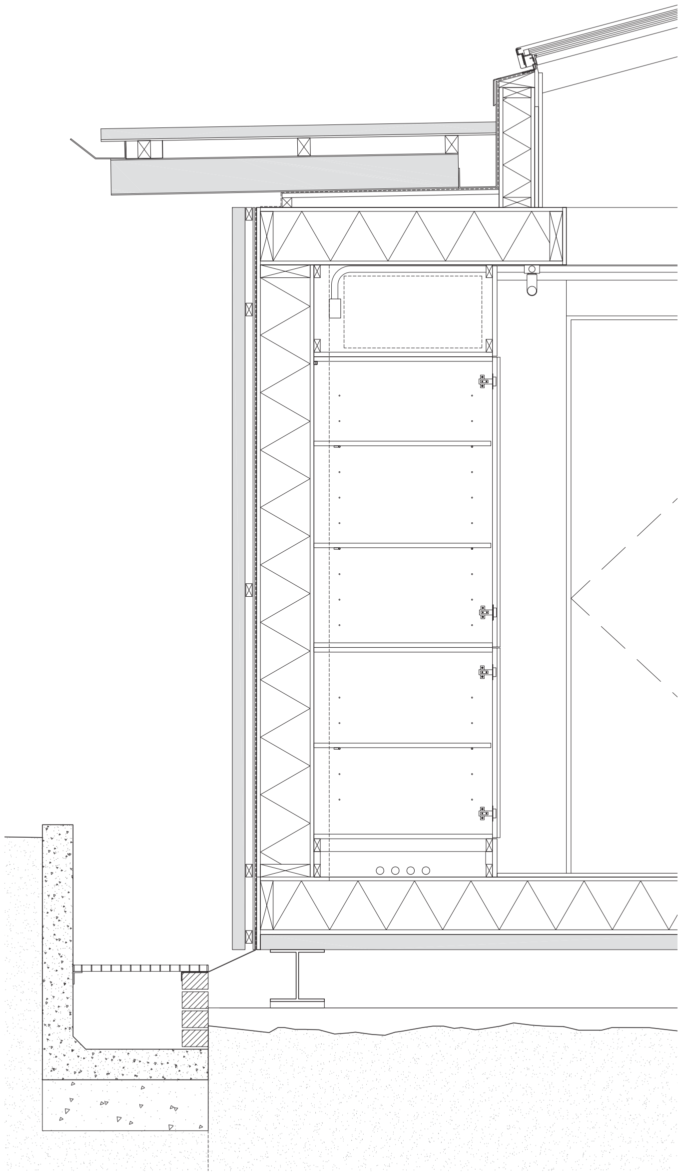
TYPICAL WALL CONSTRUCTION TYPE 2- Toilet
SIPS Panel of 12mm Birch Plywood Lacquered, 195mm Platinum EPS Core, 15mm Spruce Plywood
Resistrix EPDM Membrane
4mm composite steel sheet with applied printed murals- red
55X55mm Type N Elefant grating

TYPICAL ROOF CONSTRUCTION
SIPS Panel of 12mm Birch Plywood Lacquered, 195mm Platinum EPS Core, 15mm Spruce Plywood
Resistrix EPDM Membrane on firring pieces and sarking board
140mm galvanised steel C section roof structure
Sinusoidal galvanised steel roof sheeting
Profiled galvanised steel gutter with galvanised steel downpipe hidden in rainscreen cladding

Windows and Doors
Entrance Doors of Birch Plywood faced 95mm SIPS Panel with 4mm composite steel sheet with applied printed murals externally
Locally sourced laminated Oak Double Glazed windows and glazed doors
2100X2100mm Plateau rooflight from the Rooflight Company

Security Screens
50X25mm Charred Timber @ 75mm centres on galvanised steel angle frame
55X55mm Type N Elefant grating on top hung sliding door gear

Mechanical and Electrical
Galvanised steel surface fixed electrical conduit
All electrical outlets and switches in steel
T5 slimline luminaires surface mounted to ceiling
Daikin Air to Air heat pump with heat recovery and surface mounted steel ducts
Solar Water panel array



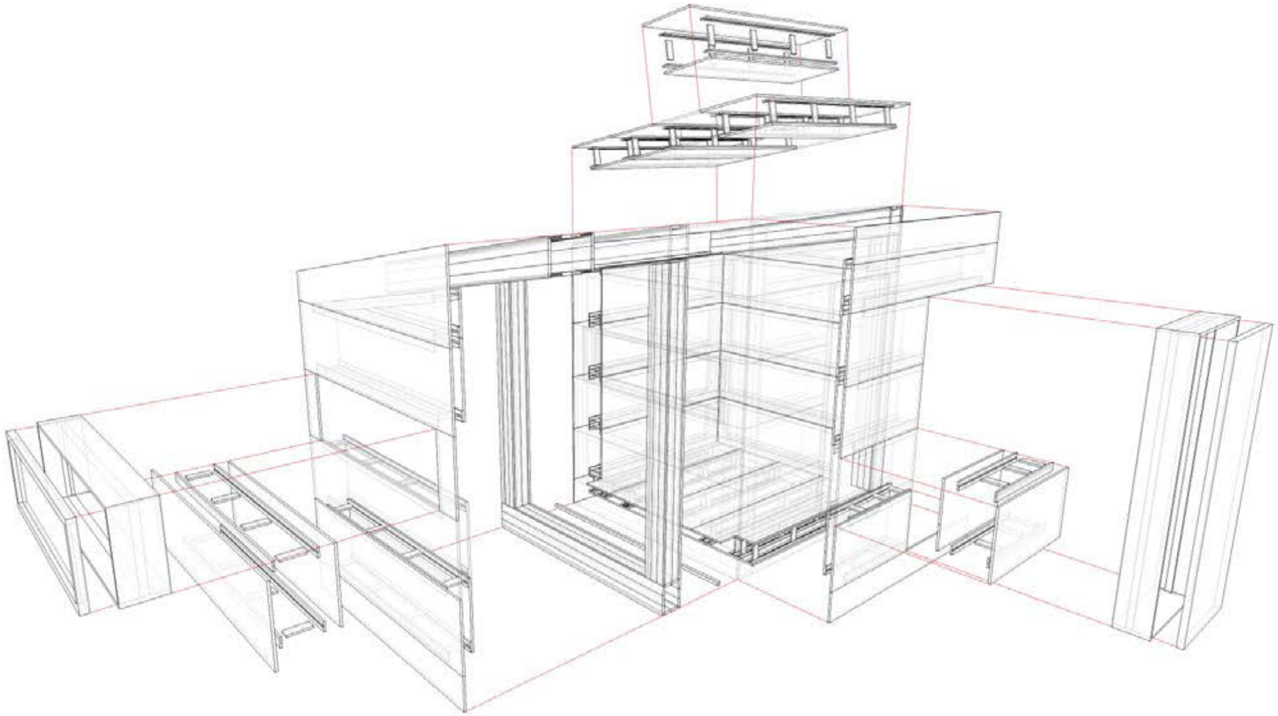
9.0 ty unnos

'Ty Unnos'– 'the house of one night'- an integrated whole house system for low carbon affordable housing- is to be developed for commerical realisation. The project is a partnership between Coed Cymru and Design Research Unit Wales (DRU-w) at the Welsh School of Architecture. The Sitka Spruce Ty Unnos project aims to create an integrated whole house system which:

- is low cost
- adds value to a poor quality timber
- is highly sustainable
- results in high quality rural architecture

Sitka spruce accounts for approximately 70% of the Forestry Commission crop. Planted following clear felling over 50 years ago, the quick growing timber has limited use in construction, employed predominantly in the manufacture of pallets, fencing and low grade carcassing timber.

The award winning system is achieved through the innovative re-engineering of a material with poor performance capabilities, low value, readily available and locally sourced into a high value low carbon whole building system. The system provides a simplified, standardised kit of components which can be prefabricated and easily assembled on site. The system is suitable for the self build, public and private housing markets.



The Context

The increase in environmental assessment of construction materials and their sourcing is critical in achieving the UK's 2016 target, and Wales' 2011 target, for Zero Carbon housing. Furthermore, recent estimates record an unfulfilled demand of approximately 40,000 dwellings per annum in England and Wales, which is unlikely to be met through traditional house building techniques. Ty Unnos aims to use locally sourced, low value components to help fill this gap in the affordable, sustainable, rural housing market.

Wales has 150,000 hectares of coniferous plantations which produce around a million tonnes of softwood in the round per annum. Over 70% of current production is Sitka spruce, a native of the Pacific coast of North America which suits Wales' mild, wet climate and peaty upland soils. In its native range, Sitka Spruce grows slowly to produce a mature timber with exceptional strength to weight ratio. However, Welsh spruce grows much faster producing timber of lower density with heavier branching and larger knots. This results in poorer structural properties than imported timber, producing a maximum machine grading of C16, and is further unsuitable for construction due its tendency to twist during drying.

Welsh grown Sitka spruce machine graded C16 is readily available in a range of standard lengths up to 4.8m with standard thicknesses of 47mm and widths from 75mm to 250mm. It is processed for a number of markets including fencing, woodfuel, chipboard and pallets. It's most important commodity is carcassing timber which is machine graded to C16, the lowest strength class in general use.

While open panel timber frame is common in the UK, advanced forms of MMC, for example closed panels or volumetric units, are not well established, particularly in Wales. The majority of available timber frame systems are dependent on imported softwoods and manufactured boards, because of the greater stability and superior strength of the slower grown timber. It was recognised that the simple substitution with homegrown softwood was not an option. If a system was to be adopted generally it would need to stabilise the main structural components and eliminate the need for conventional trussed rafters.

The Concept

Ty Unnos is inspired by Jorn Utzon's Espansiva system, a standardised additive system for low cost, low density rural housing, based on modules creating single storey homes. The monopitch Espansiva modules enable simple and varied spatial arrangements to be created with minimal structural intrusion into spaces. Modules are combined to create a wide variety of additive house types.

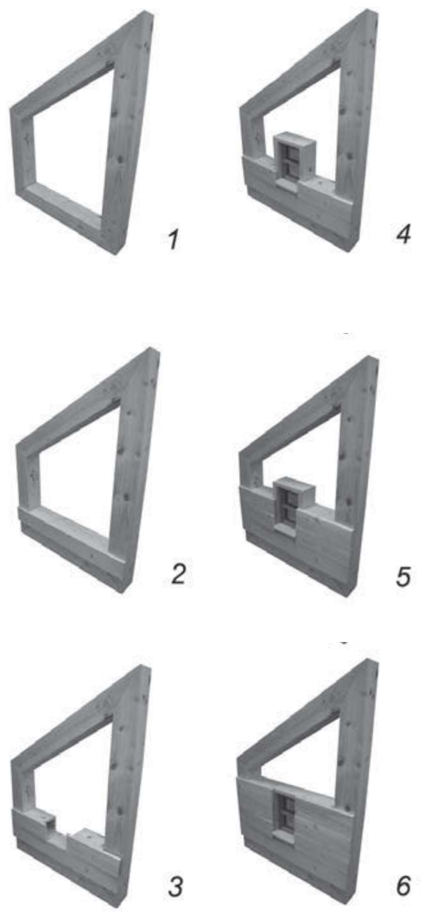
The Ty Unnos system is based on a series of modular rooms varying in sizes from 1.2m x 3m to 4.8m x 3m, or from entrance lobby to small bedroom to kitchen to living room. These are created from prefabricated box beams, using readily available lengths of Sitka Spruce, which stabilises the timber and prevents twisting. These beams form portal frames, which are infilled for floor, walls and roof using either SIPS panels or panels made up of Sitka Spruce ladder beams infilled with locally sourced sheep's wool or hemp insulation.

Developing the system

In order to achieve the required spans and roof loading appropriate to housing, the sections required would be too large to be cut from Welsh spruce without including the centre of the tree (boxing the heart). This invariably causes the posts to split and warp badly. Glue lamination of thinner sections to form solid posts and beams is feasible but the process is slow and the cost of equipment is prohibitive for small scale manufacture.

Other engineered profiles like I beams, lattice structures and box beams can be produced relatively simply by slotting components together using tightly fitting joints which hold while the glue is curing. This simplifies the cramping process and increases the throughput. Early work performed by Coed Cymru looked at creating box sections from wide spruce planks formed into a hollow box using shoulder housing joints. Producing box beams is quicker and simpler than lamination. The resulting structure is light but very strong and easy to erect on the simplest foundations.

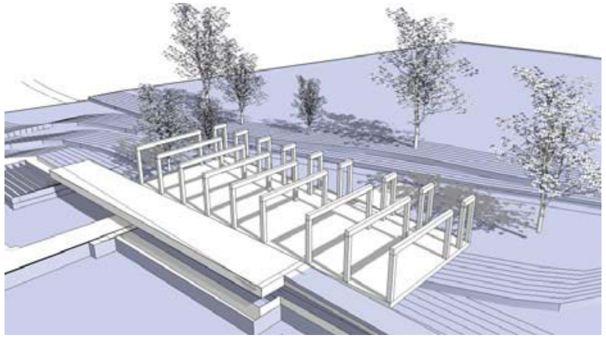
Initial testing of beams and frames has been carried out by Cowley timberwork and Burroughs. The technical performance of the box laminated Sitka spruce posts and beams well surpassed their design parameters and engineered structural loads and capacity during physical load tests. The system is now being developed with a view to certification for the mass market.

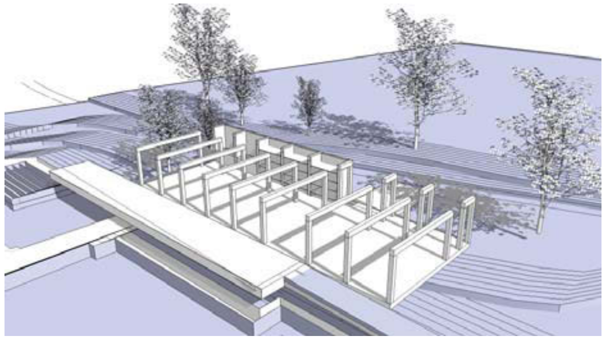


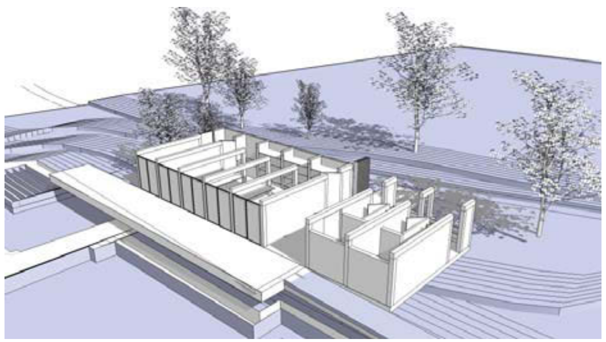
10.0 ty unnos for the ERC

Since its decommissioning the pumphouse site including the concrete fomer drainage basins had developed into a site of great ecological interest. At the introductory meeting the Client and Gwent Wildlife Trust highlighted the importance for sensitivity to the ecology to the site. The Ty Unnos construction system allows the majority of the construction to be prefabricated off-site before being brought to site and assembled. This significantly reduces on-site construction time, minimising disruption to the operation of the site and its surroundings and reducing the impact of building work on the sensitive landscape and ecology of the tanks.

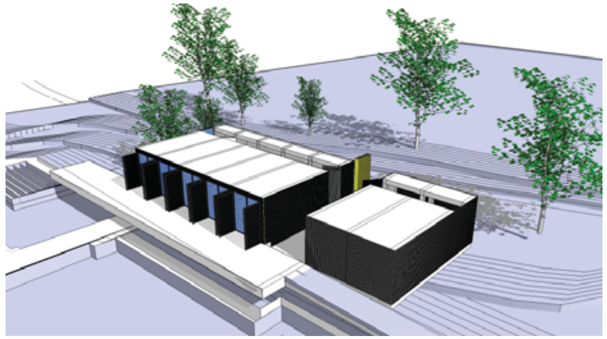
Cowley Timberwork were appointed as manufacturer for the design and detailing of the Ty Unnos frame and infil panel system for the ERC. The ERC consists of 9 paired portal frames creating 8 bays including an open entrance deck. The portal frames are paired in the east west axis to create a long span of 7.2 metres. Although originally considered as two independent portal frames connected across the main North South circulation axis, Cowley Timberwork acquired non standard lengths of homegrown spruce to prefabricate 7.2m long floor and roof beams. Columns lining the circulation routes are employed as structural props to the extended floor and roof beams. Portal frames are located at 2.4m centres along the North South axis and spanned using Structurally Insulated Panels to provide floor, wall and flat roof infil.


1. Ty Unnos portal frames


2. Prefabricated storage walls


3. SIPS wall panels and infil glazing


4. Coloured panels and roof SIPS


5. Cladding


6. Roof and rooflights

11.0 research and development

In September 2007 Coed Cymru developed and built a cramping jig at the Old Sawmill, Tregynon at a total cost of approximately £10,000, using a standard fire hose and air compressor as the mechanical force. This was successfully tested first at a length of 2.4m and then at the full length of 4.8m.

Cowley Timberwork undertook structural testing on the Ty Unnos box section in early 2008, firstly on a simple beam and then in the form of a portal frame. Tests on the box section beam were very promising with consistently high loadings being met with great efficiency. Cowley Timberwork proposed the use of bonded rod connectors to joint the box sections into a portal frame and testing was commenced by Rotafix of Ystradgynlais.

Testing was performed in two forms,

1) Firstly the box section was fixed to a hydraulic rig which exerts force up centrally on the beam working against straps at each end. The hydraulic force is gradually increased until the beam reaches failure. Failure of the beam provided great confidence in its performance for a number of reasons. As the force increased the beam responded with a number of loud splits and cracks, without any noticeable performance failure, then on breakage, which usually occurred after a significant time from first signs, the beam would fail along a weakness such as a knot or split. This is encouraging as there is significant warning on potential failure prior to actual physical failure and when failing it is timber fault rather than any weakness in glueline. Results showed that the maximum displacement under load was 14mm which was less than the permitted, and a failure load of 4.3kN.

2) The second test was to lie the portal frame horizontally, fix the steel shoes to steel plates mounted into a concrete floor slab, then using a hydraulic ram on the highest point of the vertical section, gradually apply a force to the portal and trace the deflection. This allowed the engineers to consider the performance of the portal under forces such as wind, whilst also looking for weaknesses in joints. The testing of the portal frame was then supported by calculation to provide sufficient confidence that the timber is performing in deflection as one might expect. Cowley Timberwork in conjunction with Burroughs have now established a reasonable confidence in the structural performance of the portal frame.

12.0 Off site manufacturing

Cowley Timberwork prefabricated the Ty Unnos frame and SIPS panels for delivery in March 2010......

12.1 box section structure

The ERC is created from 9 portal frames with an internal dimension of approximately 2.4m high X 6.7m long. Each portal is assembled from 4No 2.4m 270mm X 210mm columns, and 2No 7.2m 270mm X 210mm floor and roof beams. All beams and columns were manufactured by Cowley Timberwork including infilling with Sheeps Wool Insulation and transported to site for assembly.



Assembly Process

1. Kiln dry homegrown Sitka Spruce;
2. Machine and prepare Web and Flange timbers with tongue and groove profile, including groove to receive threaded rods in column ends;
3. Glue and assembly box section and exert pressure using pneumatic press for ... until cured;
4. Glue 43x184x270mm localised stiffener in beam ends
5. Install and glue 43x43x375mm local corner thickening to top and bottom of posts;
6. Install 4No M16x325mm to bottom of column and M16 coupler to top of column and fix with injected resin bond;
7. Sand and finish and surface fix bearing timbers to floor beams;
8. Apply intumescent clear lacquer to achieve Class'O' fire rating.

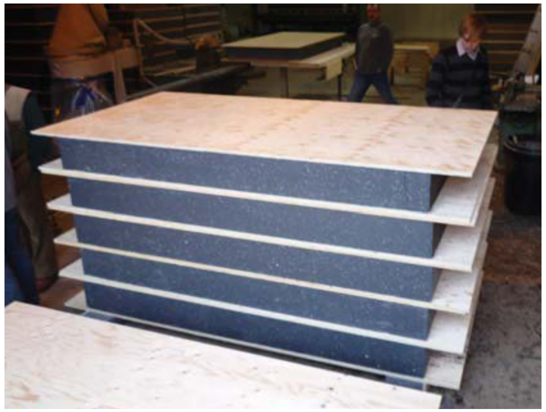


12.2 SIPS Infil Panels

Structurally Insulated Panels were manufactured by Cowley Timberwork to provide thermal envelope to all external walls, internal walls, floor and roof. The SIPs panels provided exposed internal finishes and a thermal envelope of U-Value 0.15 m^2K/W. The panels used in the ERC consist of a 195mm EPS core with 15mm Spruce Plywood to the External surface. To the floor and roof the internal finish was provided by 15mm Spruce Plywood, whilst the Wall finishes were provided by 12mm Birch Plywood.

Assembly process

1. Plywood and EPS Core trimmed to approximate size;
2. Panels assembled using ... adhesive and inserted into press in multiple loads;
3. Panels trimmed to finished size on circular table saw
4. EPS core routed using CNC cutter to recieve fixing studs;
5. Rout male and remale connection studs and screw and glue into rebate in panel;
6. Additional finishing plywood applied where necessary.

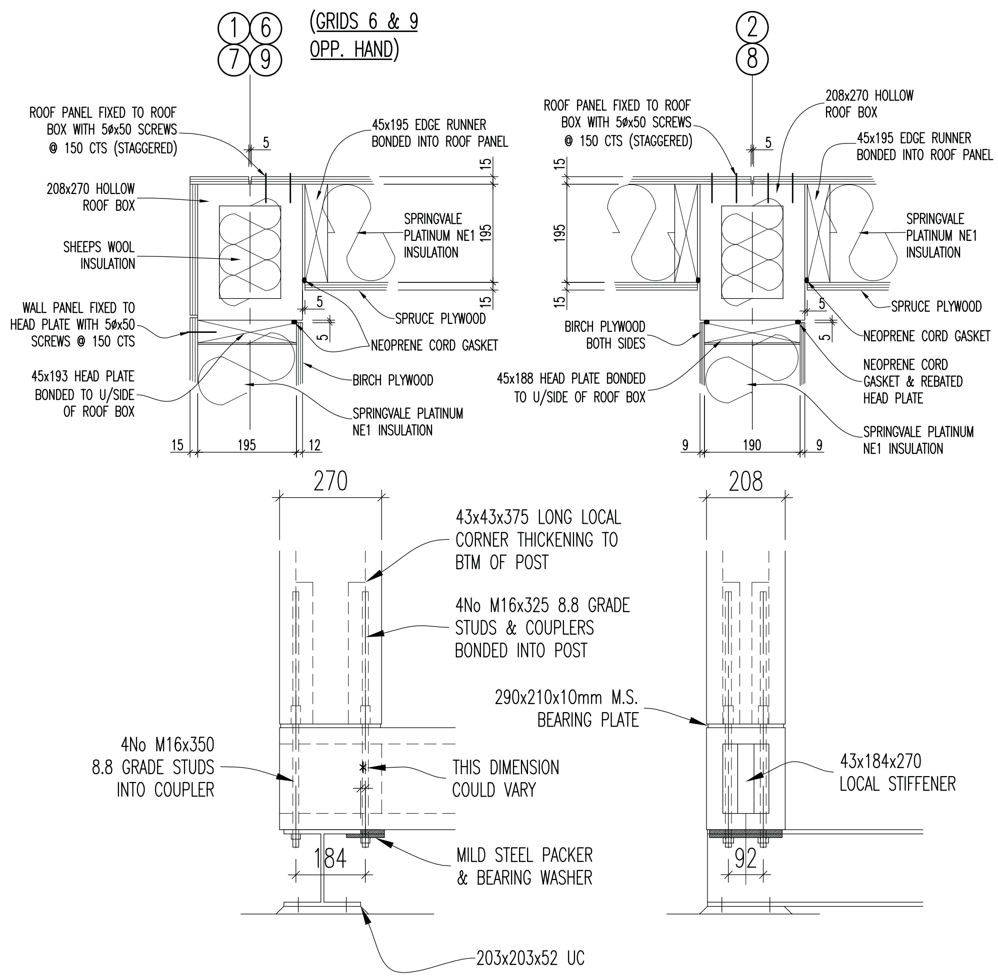


12.3 Manufacturer's comments

A 40 day design and fabrication time period was originally stated in the September 2009 construction programme.

Cowley Timberwork were significantly delayed in their fabrication of box sections due to excessive wear to their table saws caused by large knots in the homegrown timber. The problem was lessened by the purchase of a new peice of equipment however the delivery of frame was delayed.

Cowley also stated there was much greater percentage of rejected spruce than expected due to warping beyond a point that it could be machined.



13.0 On site construction

13.1 Proposed Construction Programme

Site clearance	
Preparation and pouring of reinforced concrete foundations	
Installation of Steel seperating structure	**15 days**
Assembly of frame	
Setting out of ground floor beams and temporary fixing	
Fixing of Columns with threaded rod connection into steel substructure	
Install ground floor infil panels from gridline 1	
Install sole plate	
Install from above external and internal short direction walls	
Install and fix roof beam	
Install from exterior East + West wall panels	
Install Roof Panels from Above	**15 days**
Construct Roof falls	
Apply External EPDM membrane	
Storage Wall construction on site	**20 days**
Window and door installation	**7 days**
Rooflights	**5 days**
First Fix	**5 days**
Construct Roof	**10 days**
Entrance Deck	**5 days**
Murals	**5 days**
External Rainscreen Claddings	**10 days**
Security Doors	**5 days**
M & E Installation	**10 days**
Internal Fitout	**15 days**
External Works	**20 days**
Total Construction Programme	**85 days**

13.0 On site construction

13.2 Sub-structure

In order to minimise disturbance of the ecologically sensitive site a number of lightweight foundation options were proposed with the most desirable option being a concrete pad foundation on the primary structure points. The lightweight nature of the construction system required minimal loading requirements of the foundations, with engineering concern being placed on uplift generated by the lightweight over-sailing roof rather than bearing loads.

In April 2008 engineer's Halcrow Yolles performed a full site inspection including trial pits, which identified the possibility of instability due to ironstone mining activity associated with the Black Pins Ironstone. The study recommended the construction of a continuous reinforced raft or reinforced strip construction capable of spanning 3m or cantilevering 1.5m. A proposal which did not fit with the sustainable aspirations of the design team or the nature of the Sitka Spruce construction system. Compromise was reached in the form of strip foundations located on the line of the box section portal frames.

An intermediate connection is required to ensure clear ventilated separation between foundation and the suspended timber floor, distributing loads from the timber frame into the concrete foundation whilst ensuring that there is barrier against moisture. Cowley proposed a steel shoe connection using a standard I beam section connected into the bearing foundation, with floor beam and post rods bolted through the top flange.

A number of concerns were raised by the contractor regarding the sub structure;

- Accessibility of fixings located underneath the assembled frames and floor panels would be poor;
- Permitted tolerances for locating portal frames if a fixing is required between concrete foundation and localised steel shoes.

Therefore it was decided to employ continuous steel I sections spanning north to south between trench foundations. Elongated fixing holes at grid lines to receive the threaded steel rods would allow for descrepancies. Further site investigations found the site had over 2m of made up ground requiring strip foundations with a depth of over 2m. In order to reduce the volume of concrete required, the foundation system was redesigned with 5 concrete strips. The use of continuous steels enabled the strip foundations to be offset from the portal frame locations thus allowing significantly more space to access the chemically bonded anchor bolt fixings and threaded rods.

To ensure suitable ventilation to the underfloor void and provide drainage, a concrete drainage channel was designed to skirt the building, acting both as a retaining wall and a boundary to the building edge.

12.10.2009
Concrete strip foundations poured

Foundations were constructed in October 2009, consisting of five strip foundations. Trenches were prepared around the foundations for the precast concrete retaining wall units.

Delays to the delivery of the timber frame to site meant work on site was halted once the foundations were poured. Work re-commenced in November following a revised delivery date from Cowley Timber work.

13.11.2009
Drainage channel under construction, steel beams installed

Once a delivery date for the frame was confirmed, work resumed on the foundations. 210mm steel beams were bolted across the strip foundations to support the Ty Unnos frames using chemically bonded anchor bolts.

Prefabricated concrete channels were lifted into location around the footings using a manitou to create a drainage channel that reflects the geometrical form of the filtration tanks. The site was then backfilled.

13.3 Structure

Following completion of the foundations, a scaffolding canopy was erected to cover the entire site to protect the Ty Unnos frame from winter weather during construction. Initially the project was programmed to be completed over the summer which would have potentially reduced the impact of adverse weather. However, constructing the frame during the winter was seen as a risk. In future, it would be advisable to programme projects to avoid the need for an expensive canopy.

Frame assembly was carried out by G Adams following drawings and assembly instructions from Cowley Timberwork. The process for installing panels was relatively simple however an ordered system had to be in place to ensure that no fixings were visible.

What machinery was required for lifting and manouvering beams into location. How many lorries. Did they remain on site. how many deliveries

17.11.2009
Floor beams and posts erected

18 No 7.2m X 270mm X 210mm floor and roof box beams
36 No 2.4 X 270mm X 210mm columns

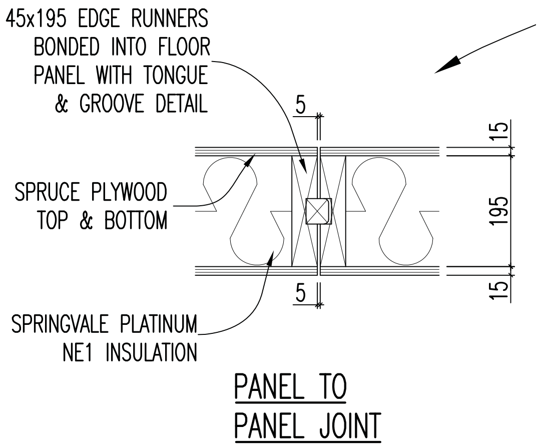
- 203mm X 203mm RSJ Steels prepared with elongated holes in upper flange at fixing points to allow for adjustment;
- Ground floor beams set out and temporarily fixed;
- 290X210X10mm Mild Steel Bearing Plate located between column and floor beam to offer additional resistance to localised compression of upper flange of box section;
- Threaded rods lowered through floor box section beam and location holes in upper flange of steel sub structure;
- Rods bolted to underside of steel upper flange;
- Setting out of box section frames was critical and challenging due to the lack of any guides or retaining structure between portal frames. The elongated holes in steelwork allows for the frame to be continuously adjusted, even during installation of the ground floor infil panels;
- Concern occurred later in the construction process when it was discovered that columns had shifted slightly during tightening of bolts. The inconsistencies were suggested to be caused by inconsistent tightening of the bolts which could have caused localised compression of the end grain timber to the bottom of the column. The knock on effect was slight descrepancies when infil panels were installed.
- As columns and roof beams were exposed internally, additional protection was required to ensure they didn't get damaged during construction. Although reasonably successful there are a number of areas of damage to the Spruce columns.
- All beams and columns were prefabricated with infil of sheep's wool insulation however the end section of beams had to be left free of insulation to ensure clear route for threaded rods. The infil onsite was originally missed.

30.11.2009
Floor cassettes installed

42 No 2400x1200mm SIPS floor cassettes pre-fabricated of 15mm Spruce plywood internally and externally bonded to a 195mm core of Rigid Platinum EPS Insulation.

Once the floor beams and posts were assembled on site, the SIPS panels for the floor were installed by hand;

- Panels prepared with male and female tongue and groove detail to allow sliding together of panels;
- Cowley Timberwork supply special panels prepared with service openings pre-drilled.



SIPS floor cassette installation process

- Panels are lifted into place and slotted between adjacent floor beams. Internal plywood lap drops onto top of box section. 45X60mm ledge prefixed to floor beams acts as additional support for floor panel;
- Starting at East elevation, panels are dropped into location and slid into place against columns;
- Further panels are dropped into opening and slid into place. Male and female tongue and groove studs locate panels and provide connection between panels;
- Once in place panels are screwed into box section frame with M5X50mm screws @ 150mm centres;
- Neoprene cord gasket installed into joint between panels to ensure air tightness;
- 45X188mm sw sole plate fixed into floor panels in external and internal wall locations
- Floor panels provided rigid working base to work from.
- Floor panels were installed extremely quickly with all panels laid in place in one day with little need for adjustment.
- Finishing pieces were applied to box section frames by Cowley timberwork which although minimising on site work meant that a reasonable level specificity was required with the location of elements.












01.12.2009
Wall cassette installation commences
Starting on grid line 1, 28No wall panels of varying widths X 2340mm height are installed by hand following a Cowley Timberwork construction sequence.
In order to enable fully exposed plywood linings without the need for exposed fixings Cowley Timberwork developed a system for installing panels which generally involved installing panels from the exterior, with fixings only to the exterior box section laps.

5mm packers were used to ensure consistent shadow gaps
Due to weight of panels sliding them into place was not easy to achieve due to the friction between panel and sole plate. Straps and ratchet sets were employed at top and bottom of panel against box section post to apply controlled pressure to the panel. Although successfully ensuring a relatively consistent shadow gap, the application of ratchets did cause some rounding and damage to finish of box section and SIPS panel.




External Wall cassette installation process

- Panels are lifted into place by hand by 4 men and dropped on to site fixed sole plate beginning at gridline C;
- Packers positioned between plywood finish and Spruce box section column and panels slid into place against post;
- Panels are provided with extended laps to cover spruce box section columns and floor beams;
- Final wall panel in each section is lifted and installed in the same way thanks to the column on gridline D not yet in place;
- Column on gridline D installed;
- Panels are screwed into box section frame through external laps with M5X50mm screws @ 150mm centres;
- Panels to cross walls installed first, prior to installation of long wall panels;
- Neoprene cord gasket installed into joint between panels to ensure air tightness;
- Internal walls have exposed plywood faces on both sides therefore additional packers are surfaced fixed to the columns first and recieved into the edge panels. The final central panel to be placed has splice plates/ tongues omitted so it can be positioned and then plywood plates slid into groove from above.

- 5mm packers were used to ensure consistent shadow gaps to recieve Neoprene gasket;
- Due to weight of the panels sliding them into place was not easy due to the friction between panel and sole plate. Straps and ratchet sets were employed at top and bottom of panel against box section post to apply controlled pressure to the panel. Although successfully ensuring a consistent shadow gap, the application of ratchets caused some rounding and damage to the finish of box section and SIPS panel;
- As panels were installed it became clear that posts were not precisely vertical. This problem was once again solved by the application of straps and ratchets across the panels.






02.12.2009

Wall cassette installation continues, beam installation commences

The first beams are installed at the classroom end of the building.

Difficulties are encounted fixing the beams. The posts were prefabricated with four threaded inserts in each post. The beams needed to be exactly located to enable threaded rods to be inserted to secure the beams. The tolerances that the frame was prepared top were so precise that in some cases threaded rods could not be located, as installation o fhte SIPS panels had causesd slight movement of the posts.

These difficulties could be overcome by erecting the frame before installing panels, but this sequence was not used in this case due to the construction of the SIPS panels.

04.12.2009

Wall cassette installation complete; beam installation contines and roof cassette installation commences

The first beams are installed at the classroom end of the building. Following the installation of the short section wall panels, and the fixing of the roof beam, the final wall sections spanning between the portal frames on the east elevations were installed from outside and fixed through the external laps.

A similar difficulty was encounted with the roof cassettes as with the beams. Due to construction tolerances, some panels did not neatly fit their intended location, resulting in some minor steps and changes in the dimension of shadow gaps internally. Panels were adjusted as well as possible including the interchange of panels and the use of ratchet straps to apply pressure whilsy fixing. Following installation of the neoprene gasket internally, the shadow gaps are largely consistent and the ceiling finish not terribly affected, particularly as the ceiling is broken up by surface fixed services.

Unforeseen issue caused by bolts standing proud of box section structure causing an interfernce with the roof panels over. Panels were therefore notched to received the bolt heads. However elongated holes then required infil to ensure that there was no potential areas of cupping of the applied EPDM membrane.

04.12.2009

Installing a roof panel

- As with the floor panels the roof is dropped into location from above;
- laps of the external plywood leaf provide only means of fixing and support however as internally the box section is left exposed without an additional ledge as found on the floor beams;
- additional laps are provided to external face of end panels to locate against external wall column;
- As with floors panels further panels are dropped into opening and slid into place. Male and female tongue and groove studs locate panels and provide connection between panels;
- Once in place panels are screwed into box section frame with M5X50mm screws @ 150mm centres;

- The ceiling finish provided by Spruce plywood is of significantly lower quality than the birch faced plywood to the walls however thanks to the surface fixed services and light quality of the panels these reduction in quality is not especially noticable other than in the lining to the roof lights.









11.12.2009
Ty Unnos structure and SIPS infil panels complete, SIPS rooflight upstand installed

During December and the early months of 2010 the site recieved abnormally difficult weather conditions with substantial snow fall and very low temperatures. During this time the contractor incurred a number of delays.

Despite being enclosed by the covered scaffolding there were a number of points of damage to the exposed Infil panels with some panels experiencing a minor delamination caused by the extreme temperatures. Fortunately these were largely external and did not affect any of the internal finished, however where required, external panels of spruce plywood were patched by contractor to provide a good working surface for application of resistrix membrane.

The internally exposed structure resulted in a challenging detailing and construction process with very little tolerance however this is generally an unusual extreme as a house would usually depend far greater on applied linings to finish walls, roofs and floors.

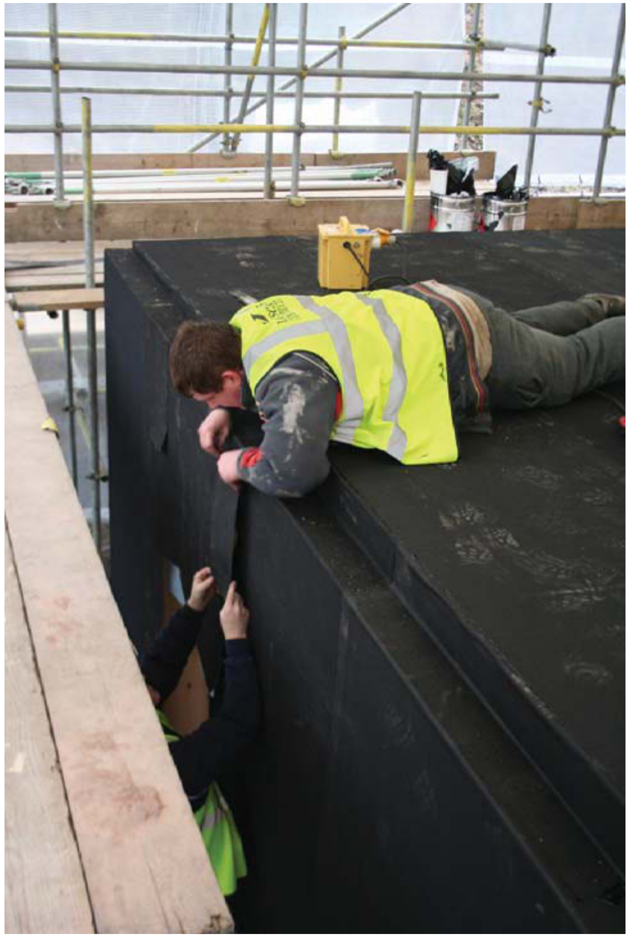
13.4 External Finishes

A resitrix membrane provides a waterproof layer that protects the timber from water damage. This is bonded to the external face of the SIPS panels and heat welded at the seams. Originally resistrix was priced by Cowley Timberwork for application to each wall and roof panel during prefabrication with laps provided to weld on site. Whilst Cowley Timberwork were happy to provide this additional element of prefabrication it was deemed that it would be cheaper and easier to apply on site in larger panel sizes thereby reducing the weaker weld joints.

27.01.2009
Resitrix membrane applied

A plywood deck was constructed over the SIPS panel roof to create a fall so water can not pool on the membrane. This is set back from the building edge to make the roof appear to float. This additional level of roof build up became necessary to provide falls to the roof finishes to allow for sufficient drainage. Alternatives such as laying the Ty Unnos roof beam and SIPS to fall were rejected due to the added complexity of detailing a shallow mono pitch roof.

Due to extremely cold weather, the Resitrix membrane was delayed and was not applied until the end of January.



19.02.10

Windows installed

Oak framed Coed Cymru system windows were installed. The tolerances between the structural opening sizes and the wondow frames caused difficulties in some cases, as strapping the posts to fit the roof beam had caused some movement in several portals. This meant that while some windows fitted perfectly into the structural openings, several others had large gaps around the frame.

Following the installation of the windows and the completion of the external membranes, the large scaffold enclosure was substantially dismantled leaving the building exposed for the first time in ... weeks. An open scaffolding remained to allow access for installation of the roof finish and rooflights.

01.04.10

Roof sheeting installed, rooflights in, scaffold being removed

In order to achieve the oversailing roof structure with overhangs to East and West and the clear span entrance deck, a steel C section framework of purlins and rafters was installed on top of the EPDM classroom and toilet roof. In order to enable fixings and rigidity over the entrance deck, the C section rafter accomodated an additional treated timber batten.

19.04.10

Roof sheeting installed, rooflights in, scaffold being removed

On top of this framework a sinusoidal galvanised steel sheet was fixed falling to a profiled shallow galvanised steel gutter to the east.

The 2000mm X 2000mm rooflights were delayed in installation due to the weight of each panel and the requirement for additional plant and the repositioning of scaffolding to allow access.

21.04.10

Coloured cladding panels fitted

Supergraphics of wildlife in red and yellow printed on aluminium panels are applied as a protective layer over the adhered resitrix membrane.

Throughout the detailing process, the application of murals as an additional layer over the membrane posed considerable detailing difficulty.

Options included;

- Coloured membrane cut into sillouette of wildlife applied to black membrane;
- Metal panels of aluminium or steel with applied graphics fixed onto battens;
- Metal panels mechanically fixed directly to EPDM membrane with self sealing grommits between panel and membrane.

The solution was to adhere Steel flat panels with applied coloured graphics directly to the resistrix membrane using...
Despite initial concerns regarding tolerances between metal panels there were very few problems with accuracy of the panels.

29.04.10

Charred timber rainscreen cladding applied to classroom

Precut and charred timber battens are arranged onsite into rainscreen cladding panels at approximately 75mm centres. Prototype panels were tested to ensure that the batten size and spacing allowed the large scale coloured graphics could be identified and revealed as the visitor moves past the building. to allow murals are applied to the outside to reveal the supergraphics from different angles. It was initially priced for cladding panels to be prefabricated offsite by Cowley Timberwork however the level of detailing and coordination required deemed this as over complicated.

11.05.10

Galvanised steel mesh cladding applied to toilet block

Charred timber and galvanised steel mesh claddings are applied to the outside to reveal the supergraphics from different angles.

14.05.10

Galvanised steel mesh security screens and charred timber shutters installed

The exposed nature of the site demanded an element of additional security. Rather than applying proprietary shutter systems it was decided to integrate shutters with appropriate cladding treatments. Shutters in the West facing classroom were also employed to provide shading from excessive solar gains.

Galvanised steel frames provide a substantial rigidity behind panels of charred timber cladding. Although significantly larger than first expected the solidity of the security screens is reassuring and mechanisms are easily manoeuvred.

Elefant grillage panels are fabricated on Henderson top hung sliding door gear to provide security screens across the entrance deck. These screens generated a number of challenging details;

- at threshold the termination of entrance deck and boardwalk to allow the sliding panel was wider than first thought creating a potential trip hazard, a temporary threshold bar was therefore installed that could be lowered whilst the shutter is open;
- steelwork to support the door became quite substantial due to the wieght of the panels and the top hung nature, there were therefore a number of engineering details required to ensure that loads were successfully transferred through the cladding layers into the primary Ty Unnos structure.

13.0 On site construction

13.5 Internal Finishes

17.03.10
Galvanised steel surface fixed conduit installed for M&E first fix,

17.04.14
Electrical fittings installed and Mechanical first fix continued

29.04.10
Storage units and furnishings installed, and Mechanical ducts in place
Plywood units line the eastern edge of the classroom providing storage for furniture, equipment and sink units. Units were initially conceived as prefabricated units that could be installed in one peice. Due to the complexity of the Mechanical and Electrical systems that are concealed within the storage wall it was decided to prepare but not assemble units off site. Units were installed with relative ease.



11.05.10
Storage units finished, and floor finish installed
Sundela faced Plywood storage units are finished with a replacable layer of sundela to allow for children to make the classroom their own.
Floor finish of charcoal linoleum is installed to the classroom and a profiled natural rubber floor to the toilets.
A number of options were considered for floor finish,
- originally intended to be left as exposed upper leaf of plywood SIPS panel, these was considered risky due to damage during construction
- a rasied floor of plywood with underfloor heating was considered to solve a number of detailing challenges
- contrast linoleum floor was decided upon following concerns raised by building control regarding contrast between surfaces.



11.05.10

Electrical finishes, and Sanitaryware

- hidden cisterns are incorporated into framed polycarbonate units with flourescent luminaires creaing a backlight to the generous cubicles;
- disabled toilets uses surface fixed contrasting fixings to ensure visibility;
- profiled troughs provide space for 6 children at any one time;
- luminaires and surface fixed ventilation ducts contrast the dark floor and plywood finishes to create a successful reflection of the industrial context of the site;
- relationship with other consultants was not as smooth as it could be meaning a number of finishing elements to the mechanical ventilation system were not as the design team intended;
- Cowley Timberwork supplied wide SIPS based doors with visibility panels which not only highlight the building's construction but gives a feeling of great durability and quality;
- Thanks to successful funding bids by Blaenau Gwent and GWT, solar panels were incorporated into the M&E package. Located at the entrance to the building the array and structure provides a clear focal point as orientate yourself around the site.






14.0 conclusion

The Environmental Resource Centre has provided a comprehensive evaluation of the economics of the Ty Unnos construction system. The contract value at tender stage was agreed at £315,000 or a price per square metre of £2250. However this figure is inflated by a number of items including expensive ground works due to site context, high levels of glazing, and a significant Mechanical and Ventilation budget. Throughout the project a number of cost studies were performed and measures suggested to reduce costs however the client and user were keen to deliver the highest quality building possible and therefore endeavoured to find additional funding.

- The actual cost of the Ty Unnos frame with infil panels and doors to provide internal finishes came to an approximate total of £64,000 supplied by Cowley Timberwork
- Erection of the Ty Unnos Frame and Infil Panels to provide thermal envelope by G Adams was approx £4000
- This equates to approximately £485 per sqm.

There were few unusual issues highlighted by Planning and Building Control posed specifically by the Ty Unnos system. The Design Commission for Wales responded positively to the system's primary objective of employing sustainable locally sourced Sitka Spruce in the construction industry.

As a portalised system the Ty Unnos frame with threaded rod connections can be successfully employed when combined with a SIPS panel to provide diaphragm action.

Manufacturer and contractor have responded very favourably to the system and would be happy to work with the system in a similar fashion again. A number of detailing issues could be reconsidered to assist buildability including;

- Threaded rod connection;
- Exposed internal surfaces without any face fixing demands a high level of workmanship and on-site protection;

The completed building has been recieved with great positivity. Initial concerns regarding the system suggested in might feel lightweight and temporary, however the reality is a high quality building with a strong sustainable profile which sits routed in its site with a definate permanence. The initial brief of sensitivity to the ecologically sensitive site has been relatively unsuccessful however largely down to the demands of extreme ground conditions. The erection of the frame and thermal envelop was achieved in less than the programmed 15 days with very minimal complications and generally without the requirement for any substantial plant.

15.0 response

15.1 Publications

Building Design 13.11.2009 First Look article following commencement on site

Building Design 08.06.2010 Picture of the Day following completion of the ERC
http://www.bdonline.co.uk/news/ebbw-vale-environmental-resource-centre-completed/5000682.article

BBC SOUTH EAST WALES 20.05.2010 Local news article announcing the official opening of the ERC
http://news.bbc.co.uk/local/southeastwales/hi/people_and_places/nature/newsid_8691000/8691899.stm

Building Design 07.2010 (tbc) Sustainability Focus article

15.2 Awards

Wood Awards 2010 Best Private/ Best Small Project One of nine shortlisted projects

FIRST LOOK

The Environmental Resource Centre, clad in vertical charred timber, will provide teaching facilities within the wildlife area.

Design Research Unit Wales uses local wood at former steelworks

Former Yaya nominee Design Research Unit Wales has unveiled a £315,000 education centre for the country's Ebbw Vale steelworks regeneration project.

The 140sq m Environmental Resource Centre, clad in vertical charred timber, will provide teaching facilities for local schools and groups within the wildlife area that has emerged around the former pumphouse and concrete filtration tanks following the closure of the steelworks in 2001.

It will be built using a new construction system which is being developed by the practice and Welsh woodland trust Coed Cymru as part of a research study into building low-cost affordable housing using locally grown softwood Sitka spruce.

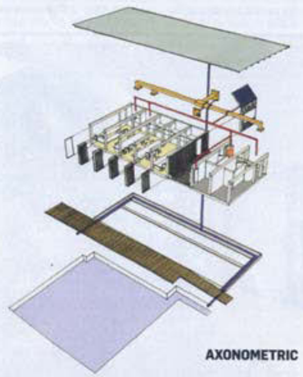
"When we saw the site we couldn't just design a building purely around the system," said project architect Steve Coombs. "We've pushed the limits of the beams a little bit so that we can respond to the industrial context."

A grid created by concrete piers in the ponds at the rear of the building, which used to support the filtration tank, has been echoed in the layout of the design alongside proportions reflecting those of the Victorian pumphouse.

Two main spaces — an office space for staff, and a classroom with an integrated storage wall and a west-facing glazed wall with sliding and folding screens — are connected by a lightweight steel roof.

A series of timber boardwalks extend out from the centre, providing access to the surrounding wildlife area and walkways over the ponds.

Work has begun on site and is due for completion in January.



AXONOMETRIC

ELEVATION

16.0 finished photographs