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Issue 119 April-June 2012
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Underground school days

Earth-covered, bushfire resistant library



Sitting 4.5 metres below natural ground, this library provides cool, energy efficient shelter for students at Candlebark School. By Sasha Shtargot.

CHILDREN might have few better places to learn than in the foothills of the Macedon Ranges, north-west of Melbourne, on the edge of a messmate forest with kangaroos and koalas for school buddies.

Candlebark School, started in 2006 by children's author John Marsden, has an innovative, free-spirited attitude to education modelled on Fitzroy Community School in inner Melbourne. So when it came to building a new library, the school wanted to display its particular style and approach to learning.

The earth-covered library is a striking example of environmentally sustainable design. It was opened in September last year and cost \$850,000—the money coming from the Federal Government's Building the Education Revolution program. Why did Candlebark choose an earth-covered building? Architect Paul Haar says the school wanted to build in harmony with the sloping topography so as to keep the inspiring view of the valley below, and it needed a well-designed bushfire shelter.

Location and load-bearing materials

The library is on a south-east slope below Candlebark's dining and meeting room, with a view into a valley of oak trees, elms and pasture. It sits on a concrete slab 4.5 metres below natural ground at its northern edge and meets natural ground level at its southern edge. The external retaining wall, made of 290mm core-reinforced concrete, is curved in a half circle. This shape more effectively resists the heavy horizontal forces placed by the earth on the wall. The south wall is curved to broader radius and consists mainly of tall counter-balanced double-hung windows and glazed doors that open to a terrace and the view beyond. Above the glazing, the south wall is framed in seasoned



↑ The LEDs are on at the Candlebark School earth-covered library.

pine, sheathed both sides with structural grade seasoned pine plywood (to retain the edge of earth laid over the roof) and clad with fully compressed cement sheeting. Windows and external doors are framed in recycled Blackbutt hardwood and the pergola on the south terrace is made from salvaged exotic cypress pine.

About 500mm of soil covers the library roof. This depth of earth shields the building against radiant heat from sun and potential bushfire in summer, cold in winter, and stores enough moisture and nutrients to feed the grass and native ground cover plants that grow on the roof. To carry such a load of soil you would think the roof needed to be made of concrete or steel, but Paul says he stubbornly clung to the idea of an all-timber roof frame because of its sequestered carbon, easy workability and aesthetics. Massive



↑ The view from the roof.

post and beam portals of seasoned pine laminated veneer lumber (LVL) were made off site. LVL slabs were shaped and vertically screw laminated into roof beams that span continuously over posts of the same section. It took four men and a crane only 16 hours to erect the roof portals on site. Waste was minimised as off-cuts were used as purlins

Photos: Kristian Laemmle-Ruff



↑ Facing south is ideal for a place of study, as southern daylight is soft and free of direct glare.

above the roof beams. Seasoned pine plywood was then laid over the roof purlins.

“In the end it turned out to be a really economical and attractive roof structure for an earth-covered building,” Paul says.

Waterproofing

So how do you waterproof an earth-covered roof? Paul did a lot of research and came up with a multi-layered design with a waterproof membrane at its core. Coarse sand to a depth of 50mm for moisture drainage sits below the soil. Underneath this is a layer of Geofabric which stops sand but allows water to pass on to the Elmich Versiflex polypropylene drainage cell which provides a cavity for water to drain freely to the roof edge. Next comes another layer of Geofabric as cushion material, a polymer termite barrier, then the Wolfin Cosmofin 1.5mm-thick reinforced PVC sheet membrane with welded lap joints. Then another layer of Geofabric for cushioning and finally the seasoned pine plywood roof sheet.

For strong thermal performance, the library’s walls are reinforced concrete blocks.

The white HomeGuard TMB plastic moisture barrier underneath the concrete slab doubles as a termite barrier. There’s R3.5 polyester

insulation in the roof and R4.7 EPS insulation in the external walls. Windows are double glazed with an argon-filled gap and window



↑ School principal and children’s author John Marsden has an innovative approach to school, and buildings.



↑ An array of LED pendant lamps hang from the ceiling.

and door strips ensure draughts and bushfire embers are kept out.

Clever ventilation

For ventilation, the library has a three-stage strategy. Firstly the windows in the south wall are opened. If the outdoor air is very still, butterfly dampers just below the head of large concrete vent shafts can be opened. The shafts extend up from the ceiling in the back northern part of the library through the earth cover to above ground level. Finally, if the inside of the building is very warm as a result of days of hot weather, mechanical fans built into part of the south wall can be switched on overnight. The fans flush the inside of the building with cool air that escapes through the ceiling vents.

Low energy lights

The library's lighting was worked out as meticulously as the other aspects of the building. Facing south, Paul says, is ideal for a room of study and reading because southern daylight is soft and free of the direct glare that comes through north-facing windows. On overcast days and at night, LED lighting with good colour rendering index (CRI) and colour temperature is turned on. In the general reading and stack areas, pendant lamps with heat sinks hang bare between and just below the underside of the roof beams, bringing the light source down closer to the children reading. These lamps are AltLED Asteria 35W LED with Cree XM-L chipsets, 100-degree beam angle, 4100K colour temperature, CRI of 80 and output efficiency of 51 lumens per watt. Even more impressive are the surface-mounted flat disc lamps fitted to the lower ceilings of the digital media room, quiet reading area, workroom/store and toilet. These ICX FP06 6W lamps have 4200K colour temperature, a CRI of 87 and output efficiency of 87 lumens per watt, emitting almost no heat.

Bushfire ready

An important aspect of the library's design is its bushfire preparedness. The school closes on total fire ban or Code Red bushfire warning days and at other times monitors the fire authorities in case of emergency, so the library serves as a fire shelter only as a last resort. Because of the lack of understorey



↑ The load-bearing roof under construction

in the nearby messmate forest and the peculiarity of the topography, the school, Paul says, has a reasonably low Bushfire Attack Level. Regardless, the roof and three sides of the building are underground, so the library stands well shielded from fire. The exposed south window wall of the library is clad with fully compressed cement sheet.

External doors and windows in the wall have BAL-29 thermally toughened, sealed insulating glass and are fitted with custom-made heavy duty BAL-29 stainless steel insect screens.

Paul has also designed a drencher system for the window wall. The system will include 15 Techpro BDQ T1 1740 X-vane square cone brass spray nozzles. These will be fitted to a 50mm copper supply pipeline, in turn fixed to the underside of pergola beams out 500mm from doors and window heads. The nozzles can each spray 7.4 litres of water per minute to protect against radiant heat and ember attack.

Paul and John Marsden are pleased with the library's performance not just as an environmentally sustainable structure, but the quality that it inspires in Candlebark students to study, play and explore. *

Architect Paul Haar can be contacted on 0409 011 335. For more of Paul's designs see *Once a factory, now three homes*, in *ReNew 114*.