

**Location:** Jubilee Highway, Mt. Gambier, South Australia

**Owner:** Carter Holt Harvey

**Architects:** Ross Henry

**Engineer:** P.J.Yttrup and Associates Pty Ltd

**Builder:** Boulderstone Pty Ltd

**Construction Date:** 1988



written by: Susan Ferguson | with: Greg Nolan | design: Peter Walker



# Store Building

Mount Gambier - South Australia

The construction of industrial buildings provides a ready proving ground for new and economic construction methods. The adoption of nailed gusset technology in Australia and the resultant construction of timber portal frame buildings in the country is one example of this. Both reached maturity with the glue laminated timber and **LVL** portal industrial buildings of the late 1980's.

Engineer Bruce Jordan designed Australia's first LVL portal frame building in 1985 for the South Australian Timber Company's plant in Mt. Gambier. Though its 15m span was relatively small, it established the design characteristics of using sections as columns and rafters, joined with nailed **gusset plates**, that would be developed in later industrial and commercial portal buildings.

The Scrimber International plant, designed by architect, Ross Henry and engineer, Peter Yttrup, deploys and develops this technology to provide five interconnected buildings, enclosing an area of 10,000m<sup>2</sup>. The buildings have spans ranging from 12 to 32m and datums of 6 to 15m. All of the building frames, purlins and girts are fabricated from **laminated veneer lumber (LVL)**. The decision to use LVL was made after a detailed cost comparison with steel, suggesting that timber was economically competitive for this scale of building.

top right  
aerial view of the Scrimber  
plant

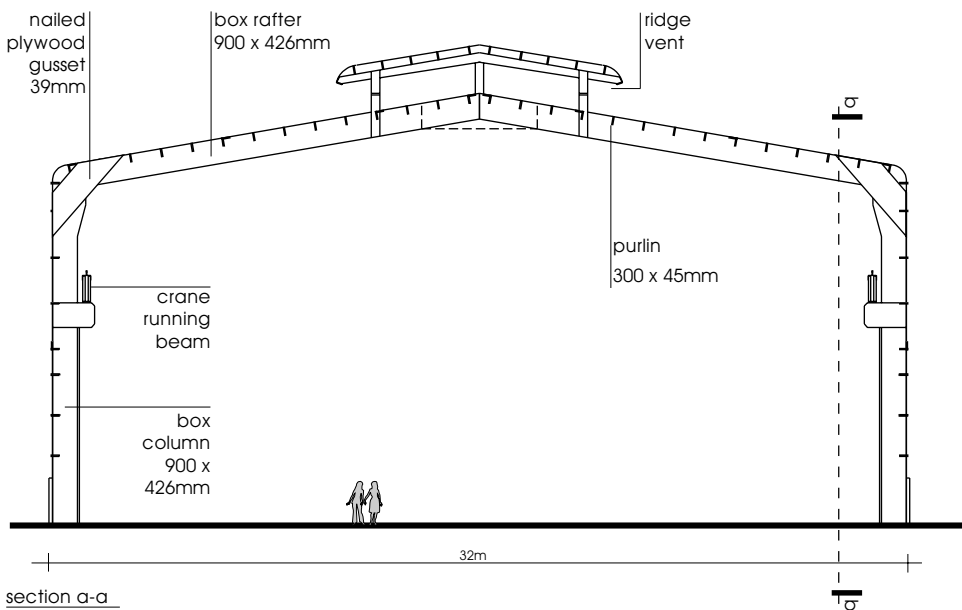
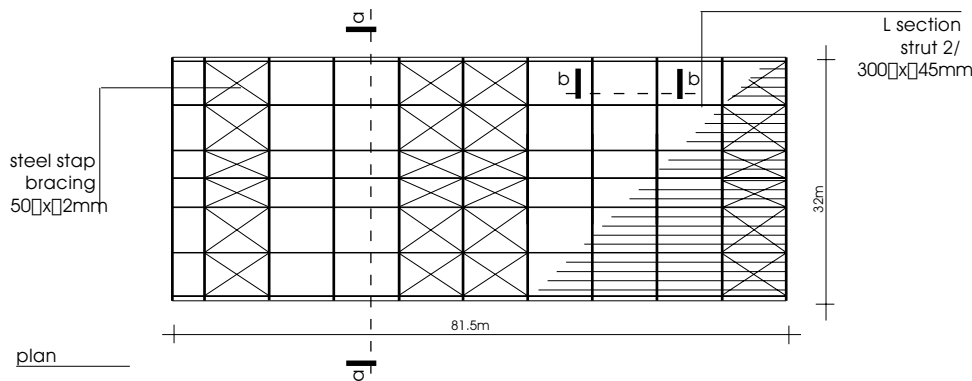
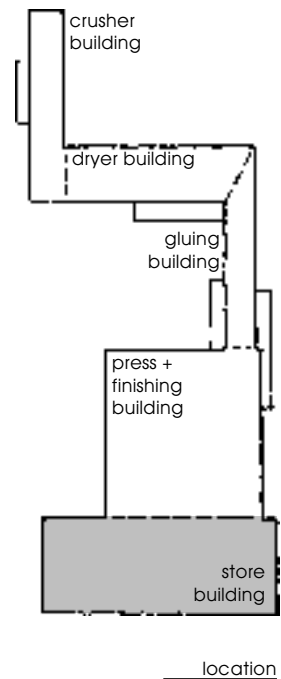
main image  
the warehouse portal under  
construction  
all photos - courtesy of the  
engineer

• **Description** - Scrimber was the product of a patented process that involved the "harvesting, de-barking and crushing of small diameter pinus radiata logs to form a mat of interconnected strands of timber." Mats were dried, glued, weighed, pressed and cut to length. The capacity to produce sizable lengths of the material meant that it had the potential to be used for domestic, commercial and industrial applications. It failed to become a commercial product, however, because the technical problems of full scale production could not be resolved.

The five buildings that comprise the plant at Mt. Gambier were designed to serve the crushing, drying, gluing and pressing, warehousing, fabrication and finishing stages of the process. The building design deploys four different LVL portal types, clad in a combination of sheet steel and 2.4m high tilt up concrete panels that form the base walls and the machine and control rooms. Engineer, Peter Yttrup's objective that only nails be used for jointing was realised apart from the bolted footing connections and strap bracing. The avoidance of drilling or punching in brackets promoted considerable cost savings on the project.

The crusher building, a skillion portal frame, spans 13.5m and is 10m high. Rafter and columns are 600 x 63 LVL sections with nailed plywood gussets that provide for full moment connections. The drying building is a skillion frame that spans 18m, with 600 x 63 LVL rafters and paired columns and 400 x 63 LVL knee bracing. The frames are spaced at 6.3m centres with 200 x 45 LVL purlins and girts at 1200 centres. The press and finishing building has continuous spans of 21, 18 and 14.5m and a total width of 55m. Frames are spaced at 14m centres with 600mm deep LVL and plywood C-section purlins at 1200 centres. The rafters are 900 x 63mm LVL sections restrained by the purlins. The warehouse is a full portal system.

On ground assembly and progressive crane lifts, a technique developed by Yttrup, was used to construct the crusher, dryer and gluing buildings. All of these buildings were fabricated with the columns hinged to the rafters with all of the purlins and girts installed. Upon crane lifting the rafters, the columns rotated into position. The press and finishing building was constructed by standing the columns up unsupported on their rigid base connection. The rafters were then lifted into place as half span pairs with purlins attached.



- top right skillion portal of dryer building under construction
- middle right c-section purlins of the press and finishing building
- bottom right diagrammatic layout of the plant
- above left roof plan of store building showing bracing locations
- left section a-a (through store building)



• **Structural Description** - The store building is the largest structure in the complex. It is a 32m span fixed portal frame structure with 9 bays at 8.5m centres and one at 5m. The portal is 12m clear at the eaves and rises to 15m at the ridge.

Columns and rafters are fabricated from 63mm thick LVL forming a box section 900 x 426mm. The roof purlins and wall girts are 300 x 45mm LVL spaced at 1200 centres. The walls were trussed with 50 x 2mm steel straps and 90 x 45mm pine noggings.

The LVL purlins and girts are set between the box portal section, while the columns support a 48 tonne travelling stacker crane on LVL running beams. The primary bracing for the crane is two LVL T-shaped braces. To resist the large moments in the portal, a 63mm thick lapped plywood gusset plate was designed, fixed with rings of machine driven nails. Yttrup comments that "the ability to manufacture special lay-up ply or LVL in the LVL press provides a very versatile material with many possibilities."

The warehouse building was constructed using a "stick by stick" assembly, dictated by the size and traditional form of the portal.



top left  
portal under construction

top right  
interior of store showing crane running  
beams and bracing

bottom right  
the completed warehouse

## A strategy for design with timber

• **Portal building in Australia** - Until the 1930's, industrial buildings in Australia generally had saw tooth roofs. The cost of artificial light was prohibitive so these buildings had to rely on controlled natural light. As a result, they were often post + beam structures with long parallel chord trusses running in one direction connected by a series of skillion trusses that ran in the other, and opened to the north.

Although timber was widely used in industrial building, the portal form did not develop in timber because it relied on rigid joints. As mortise and tenons were the predominant jointing method at the time, it was very difficult to provide the rigidity a portal required.

A portal relies on the columns and rafters to be rigidly connected and the loads to be resisted by bending in the elements. It was not until after WW2 that better jointing systems enabled rigid timber portal joints to be constructed and new computing technology was able to reliably calculate the loads on them.

Plywood portals began to be deployed in building schools, church halls and factory buildings in the 1960's. As timber was then a 'stick product' it was difficult to achieve long spans in a single piece. This was overcome by using plywood box sections as the rafters and columns.

In 1983, a decision was made to build a plant in South Australia to produce LVL, a reassembled timber product that could be produced in long lengths and had reasonably regular structural properties. LVL was used widely in industrial portals in the late 1980's before being employed with nailed gusset techniques in a series of key commercial buildings.

• **Scrimber and Plantation Stock** - Scrimber was a product developed by the CSIRO and it is relevant to discussion about all plantation stock. Plantation forestry practice works on the basis that it is best to plant more seedlings than required, as some will grow quickly, while others grow slowly or die. As the plantations mature they are thinned. Weaker trees are removed to encourage further growth of stronger trees - a standard genetic selection technique. The question then is - what do you do with the weaker and smaller trees that are removed? Often they are pulped.



The CSIRO, who patented the Scrimber process, pursued this question based on the thinking that rather than pulping, it was possible to crush the juvenile trees to retain the long fibrous material that could then be reconstituted to make other building products.

While Scrimber did not make it to the market place, another product called "Paralam" (an American initiative) has been developed whereby low grade logs are sliced into veneer and cut into 5mm x 25mm sections in 2m lengths which are then laid out in long sections and glued to make billets. This has an advantage over LVL because it allows for greater thickness and therefore large, deep and thicker structural members. The only other way to achieve this is by glue lamination which is a relatively expensive process.

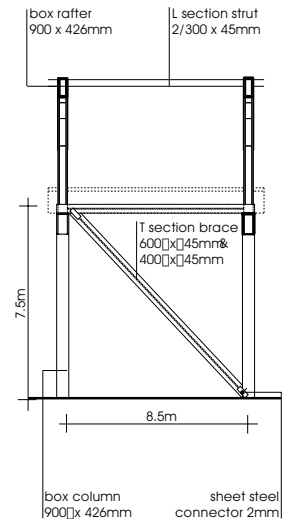
The question in Australia still remains - plantations do provide a lot of small dimension material that is not suitable for conventional sawing but is still a highly usable product. Although these "sticks" are effectively columns they do taper. Historically it was common that structural members - columns, roof beams and rafters - were often irregular in shape. Perhaps it is our contemporary perception that we prefer regular, flat surfaces. It is possible to think that these smaller, tapering, irregular members could still be used for these purposes with simple flattening off techniques. Unfortunately there is little interest for such a move within current building practice.

left  
on ground assembly and crane lift of  
dryer building

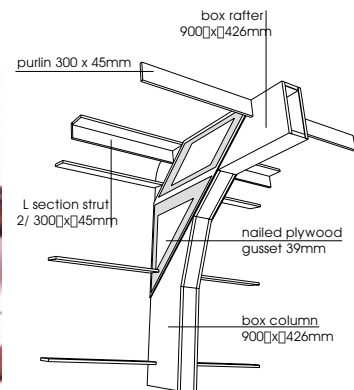
middle  
box column and bolted footing  
connection

right  
gusset plate connection and crane  
running beam

below  
bracing bay and gusset plate details



section b-b (bracing bay)



gusset plate

### • references

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### • glossary

**gusset plate:** plates, often steel or plywood, fixed by nails, bolts or other means to connect timber members in a truss or other frame structure. Gusset plates may be applied to one or both sides of a joint

**LVL (laminated veneer lumber):** a structural lumber manufactured from veneers laminated into a panel with the grain of all the veneers running parallel to each other

**portal:** a planar frame where the lateral and bending forces are transferred by moment resisting connections from the portal rafters to the columns

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