TIMBER CONSTRUCTION – CONCRETE FEEL
Carter Holt Harvey Manukau Building 4 Extension

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INTRODUCTION

The conventional structural form for most commercial floors is either a concrete or steel framed structure, with a concrete floor topping. An alternative concept is a concrete-topped timber-framed structure, with the benefits of cost and time savings in construction and significantly reduced seismic mass for design.

ARCHITECTURAL OVERVIEW

Carter Holt Harvey's office complex in Manukau City has recently extended an existing building, containing a Cafeteria, Recreational Areas and Changing Rooms, Meeting/Training Rooms, and Offices. The project has provided a new identity to the total building, which focuses on the use of the Company's products. This has included engineered timber (Ecoply plywood, Laserframe stress-graded framing and Hybeam and Hyspan laminated veneer lumber or LVL) for structural componentry, which primarily dictates the shape of the façade and creates a synergised exterior between the old and the new.

***Photo 1:** The finished building*

The facade uses fibre cement cladding (Titan Board), its main ingredient derived from wood and incorporates tinted glazing to achieve a simple but striking look. Where possible the internal structural elements have been left exposed and are incorporated with appearance products such as Plygroove, which shows its enhancing nature when careful design initiatives are used.

STRUCTURAL CONCEPT

The project involves a two storey office/seminar facility, which forms an extension to an existing two storey reinforced concrete framed building with a lightweight roof.

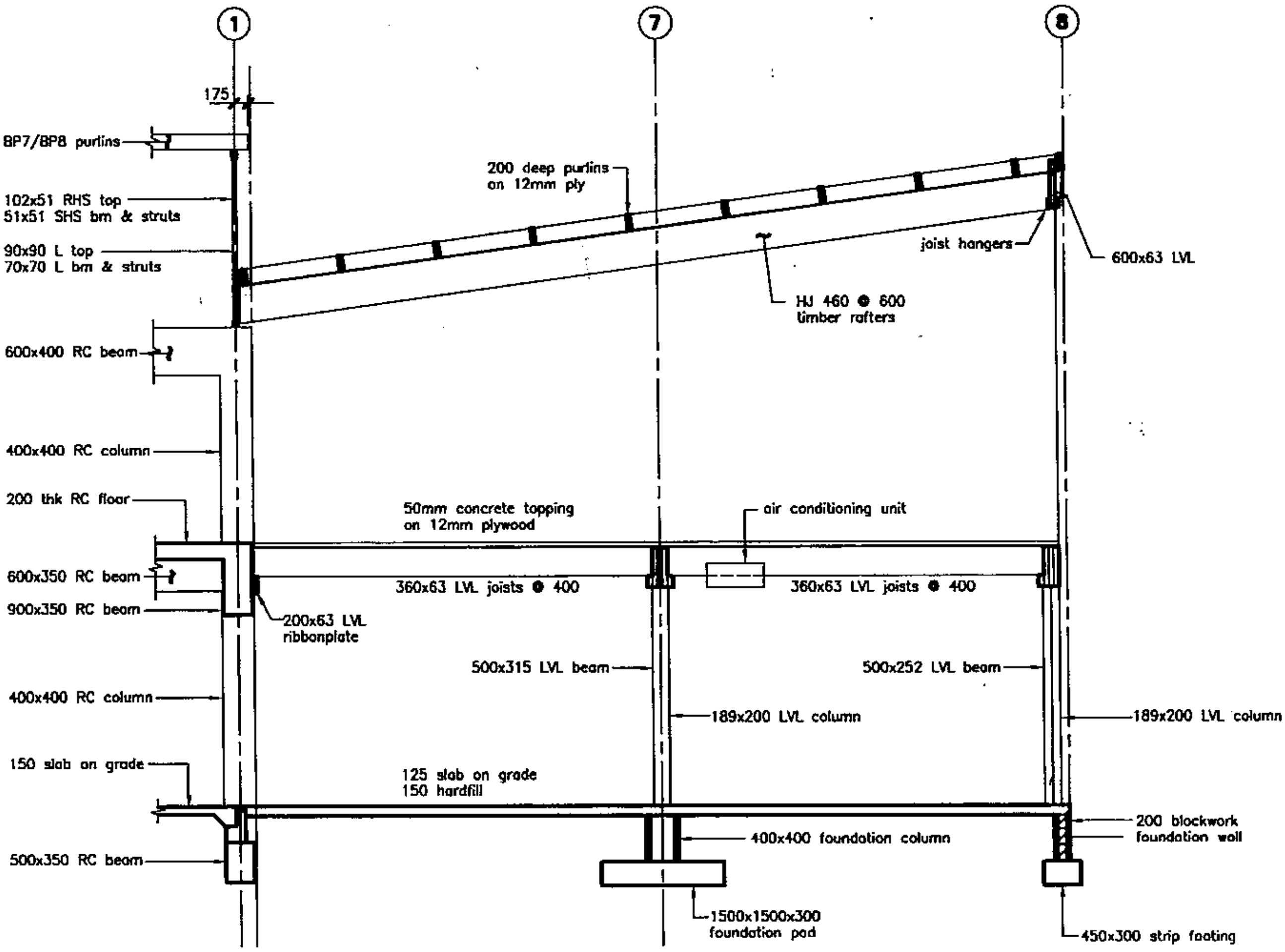

Figure 1: Typical Building Section

Seismic weights due to dead load were analysed as 9.0 kPa for the existing reinforced concrete building, and 2.6 kPa for the extension, a reduction in mass of over 70%. A modal analysis was carried out using Etabs to verify that the existing building was capable of resisting the added seismic mass of the extension. The existing building on it's own was analysed but with the seismic mass and mass moment of inertia altered to reflect the building with the lightweight extension added.

The existing building did not have the capacity to resist the seismic load from a concrete-framed addition.

The extension was then able to be designed as a lightweight construction, relying entirely on the existing building for lateral support. Loads are transferred to the existing building via floor and roof diaphragms.

UPPER FLOOR SYSTEM

The upper floor has design loads of 1.6 kPa (dead load), and 3.0 kPa (live load).

The gravity loads are supported by 12 mm thick CD Ecoply plywood and topped with 50mm of ordinary weight concrete to provide enhanced acoustic performance, specified to reduce impact noise and airborne sound transmission.

The concrete/plywood floor spans across Hyspan floor joists, which in turn are supported by a laminated Hyspan post and beam system.

The floor joists are Hyspan 360 x 63 @ 400 mm centres, spanning 5.0 metres. Dynamic criteria controls selection, to ensure that a 1 kN point load onto a single joist deflects less than 1 mm, and so the fundamental frequency is greater than 12 Hz.

The joists are supported by a ribbon plate fixed to the existing building perimeter beam, and by Hyspan beams and posts on the two outer support lines.

The floor beams have been glue-laminated from three 500 x 63 Hyspan sections plus 140 x 63 Hyspan to support the joists. The maximum span of the beams is 7.85 metres and they have been designed assuming they are simple spans, but are site-spliced to obtain some continuity over the support posts. Splices are located at points of contraflexure, approximately 1.2 metres from internal supporting columns, and configured so that gravity loads are transferred through the scarf joints to minimise mechanical fixings.

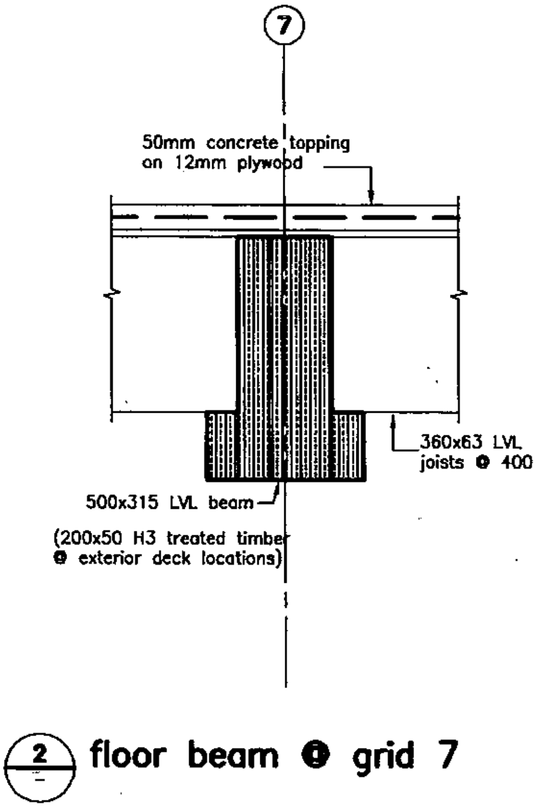

Figure 2: Floor/joist/beam detail

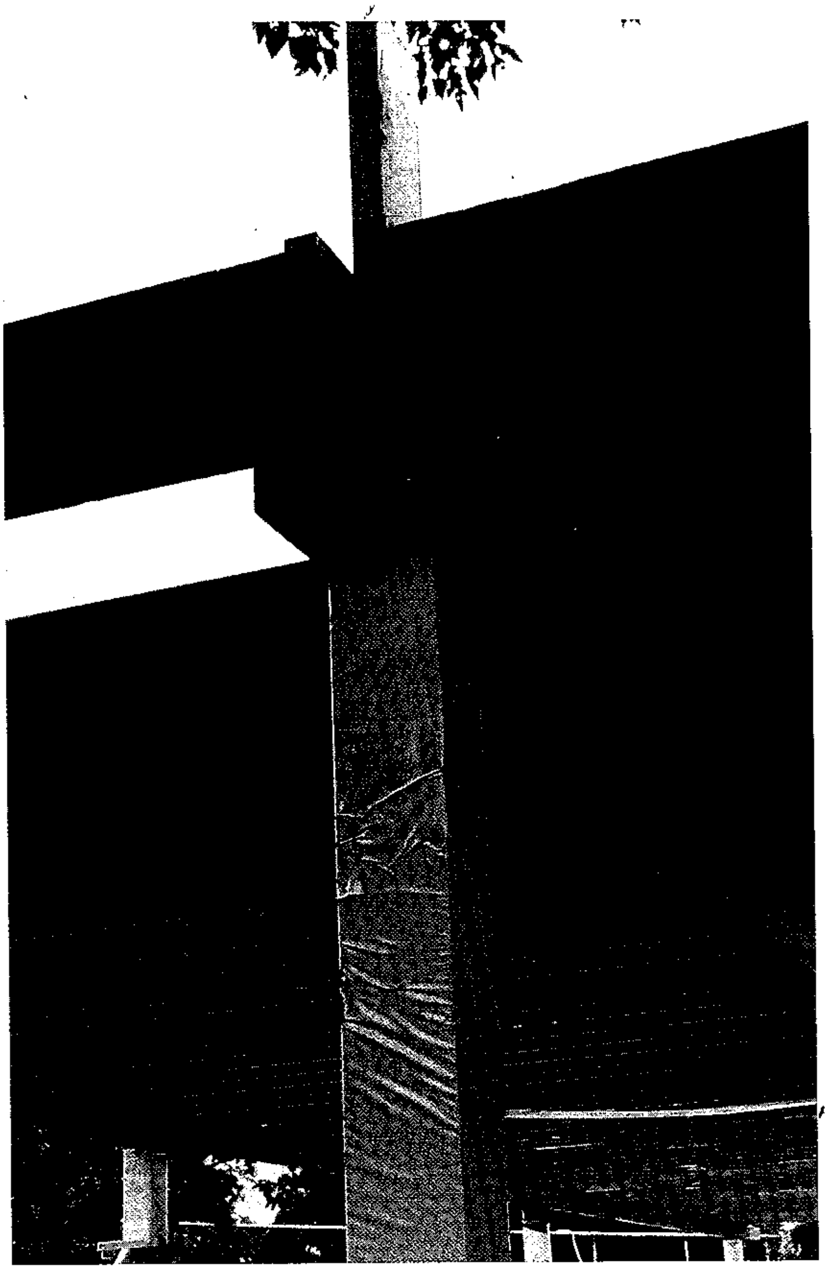

Photo 2: *Floor/ joist/ beam detail*

The floor support posts are laminated from 3 sections of 200 x 63 Hyspan to give a 200 x 189 section. The central section of the posts extend through the beams to make a positive site connection.

Horizontal seismic loads from the 24 metre x 10 metre floor area are transferred to the existing building by a plywood floor diaphragm, which also serves as formwork for the concrete topping. The diaphragm chord tensile connections to the edge of the existing building are achieved by D16 bars epoxy grouted into the existing reinforced concrete perimeter beam, and welded to a plate nailed to the perimeter Hyspan joist. Shear and tension connections to the perimeter are made by Lumberlok CF1 cleats at every 7th joist. The plywood is nailed to the joists and edge nogs to transfer lateral loads to the perimeter.

FIRE AND ACOUSTIC PERFORMANCE

The acoustic performance of the completed system (including carpet and 9.5 mm Gib suspended ceiling) was calculated by the project acoustic consultants as 59 STC and 65 IIC, and subsequently confirmed by field testing.

The floor system has a 30 minute fire rating to separate the upper and lower spaces. This has been achieved by installing 63mm wide joists, and using the inherent fire resistance in solid timber to avoid the need for a fire-rated ceiling under the floor structure.

ROOF SYSTEM

The roof, with design loads of 0.45 kPa (dead load), and 0.25 kPa (live load), is supported by 450 deep Hybeam (Hyspan chords and Ecoply webs) rafters @ 600 mm centres, spanning the 10.8 metre width of the extension. This is a lightweight but stiff solution, with stiffness criteria under long-term dead load controlling selection.

Wind and seismic loads are transferred through the 24 metre x 10 metre roof area by a roof diaphragm. Chord tensile connections to the edge of the existing building are achieved by a steel bracket welded to an existing bracket on the reinforced concrete perimeter beam, and nailed to the perimeter HJ460 rafter. Ecoply 12mm thick DD plywood is nailed to joists and edge nogs to transfer lateral loads to the perimeter. This plywood also provides mass and support to the acoustic roof membrane – the building is under the main approach route to Auckland International Airport.

ACOUSTIC DOOR SUPPORTS

The upper floor space can be separated into seminar rooms by acoustic doors. These weigh some 50 kg/m2, and are supported by a 600 x 63 Hyspan lintel to limit deflection to below 15mm over the 10 metre door span. The door track is "pre-cambered" in the open position, and the predictable stiffness of Hyspan ensures that the track is flat when the door is fully closed. Lateral stiffness to the door is provided by C-beams consisting of continuous 90 x 45 Hyspan chords and 7mm Ecoply webs spanning the opening.

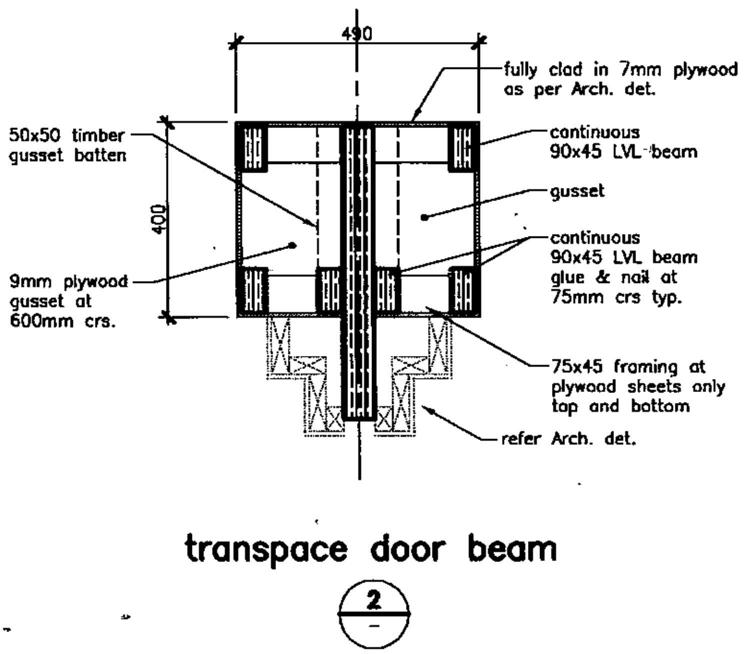

Figure 3: Transpace door beam

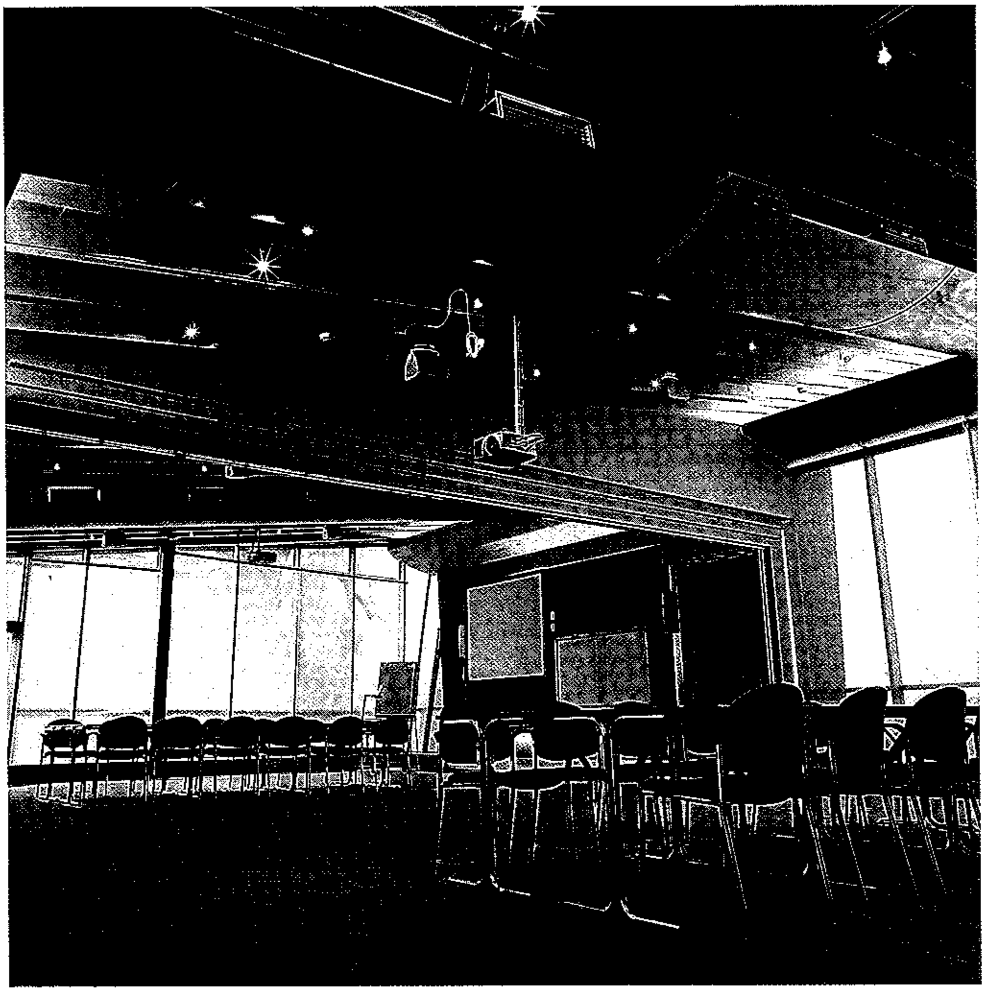

Photo 2: *Building interior*

CONCLUSION

Laminated veneer lumber (LVL) products can now give designers a structural alternative to conventional steel and concrete commercial floors. LVL has benefits for designers in its enhanced strength, stiffness and material reliability, while a lighter structure can have a significant effect on building foundations and adjacent structures. For builders a timber solution means lower construction time and cost.

PROJECT TEAM

Architect:	Fitzpatrick Cordero Ross Architects & Interior Consultants Ltd (Joey Cordero – Director)
Engineer:	Holmes Consulting Group (Warwick Banks – Associate Director)
Construction:	Hayden & Rollett Construction Ltd (Nigel Carncross – Foreman)