HOLLOW TIMBER POLES: 
TE WHAREHOU O TUHOE LIVING BUILDING CHALLENGE

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ABSTRACT: The concept of hollow timber poles, where the juvenile core material is removed from a log to provide hollow members of up to 18m in length, was first introduced by the author 1 at WCTE 2012. Cost effective hollow pole structural elements have now been incorporated in the design of a number of structures and used as piles, columns, struts, walls and floor systems. Simple structural connections, using bolted internal steel tubes, post-tensioning tendons, screws and timber notches have enabled the creation of solid wall and floor panels. For shear wall design post-tensioning tendons have been inserted through the hollow core to provide resilient structural systems. Hollow poles have been commercially developed by TTT Products Ltd Tuakau and are marketed as MultiPoles©. This paper describes the application of hollow poles as piles, walls, columns and floor elements in the Te Wharehou O Tuhoe Project, a new tribal council and administration centre at Taneatua NZ designed to fulfil the requirements of the Living Building Challenge (LBC).

KEYWORDS: Hollow poles, timber piles, water jetting, post-tensioning, timber floors, composite timber concrete floors, shear walls, floor diaphragms, Living Building Challenge, MultiPoles©

1 INTRODUCTION

In New Zealand mlb Consulting Engineers and TTT Products Ltd have developed hollow timber radiata pine poles to form structural elements such as beams, columns, wall and floor panels. Because hollow timber poles have been found to be dimensionally more stable and exhibit significantly less drying checks than solid round wood, much higher quality structural elements are possible, offering designers attractive structural elements for use in commercial and residential buildings. Together with improved material stability the hollow core provides opportunity for efficient concealed connections. Bolted internal steel tubes for column base connections, column-splices and brace junctions together with post tensioning tendons for shear wall anchors have been successfully used. Reinforcing bars cement-grouted into the hollow core of timber MultiPole piles provide a positive connection between piles and foundation platforms.

Preservative treated MultiPole piles have achieved a 100 year durability classification due to 100% treatment of the wood fibre. Tolerance fit machined scallop connections between hollow poles have been developed by TTT Products Ltd to create solid timber wall and floor panels (see Figure 1). These new structural components have been used in the first Living Building Challenge project in New Zealand; Te Wharehou O Tuhoe (see Figure 2). This project incorporates hollow pole piles, columns, braces, floor panels and post-tensioned shear walls.

This paper illustrates different structural components and the application, advantages and challenges of incorporating these new hollow pole structural elements in this landmark LBC project.

2 STRUCTURAL DESIGN: Te Wharehou O Tuhoe

2.1 Performance Requirements

Seismic loading was the dominant hazard for this project. The site is prone to soil liquefaction under strong ground shaking. The typical NZ code prescribed risk category and design requirements for a community facility were extended to ensure minimal damage under a design earthquake and to ensure continuing occupancy after a major seismic event.
The site is also exposed to high winds and is subject to surface flooding from surrounding surface run-off, and in extreme weather conditions from river flood waters. In addition to the physical characteristics of the site the development was required to satisfy the principles of the Living Building Challenge by minimising embodied energy and toxic materials within the structure. Recycling and reuse of building materials at the end of the structure life was also a key requirement. Hollow timber poles were used extensively as they are structurally efficient and require less energy to process. Mechanical fixings were used to connect timber components to avoid the use of toxic adhesives and to enable future building deconstruction.

2.2 Structural System

The development comprised two main buildings: reception and administration facilities housed in a two level structure connected by a link way to the main tribal meeting hall containing a commercial kitchen, library and environment controlled Taonga storage facility.

The structural system for the buildings consisted of hollow pole and glulam timber beam elements. Bracing walls and floor diaphragms were fabricated using mechanically fixed hollow timber poles. Timber MultiPole piles were used to avoid building settlement due to compressible subsoil and potential earthquake-induced liquefaction. Where appropriate post-tensioning tendons were installed in the wall panels to provide efficient resistance to earthquake loads. The walls were designed to exhibit a controlled rocking mechanism under extreme seismic load while minimising structural damage and avoiding residual deformations.

2.3 Material Considerations and Structural Concept

Timber was chosen as the structural material as it is sympathetic with the desire of the indigenous Tuhoe people for a building in harmony with their natural environment and forest landscape. Consideration was given to the use of locally owned and felled timber for use in the development.

Selection of renewable plantation grown radiata pine timber as the principal structural material was consistent with the LBC where “all materials in the built environment are replenishable and have no negative impact on human and ecosystem health”. Non-hazardous micronised copper azole and boron timber preservatives were used.

3 CONCLUSIONS

The use of hollow timber pole members together with glue-laminated beams and sawn timber secondary framing has provided a unique, highly robust and environmentally sustainable facility in keeping with the values of the Tuhoe people and the principles of the Living Building Challenge.

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