DESIGN PROCEDURE FOR LONG-SPAN POST-TENSIONED TIMBER FRAMES UNDER GRAVITY LOADING

Wouter van Beerschoten¹, Alessandro Palermo², David Carradine³ Stefano Pampanin⁴

ABSTRACT: This paper describes the development of a design procedure for post-tensioned timber frames. Within the design procedure the connection stiffness forms an essential component as it influences the deflections of beams and bending moment distributions in the frame. A new model for the connection stiffness has been developed and verified using Finite Element Modelling. The design procedure has been verified by full scale frame tests with one and two bays subjected to gravity loading.

KEYWORDS: Timber frames, LVL, Post-tensioning, Gravity loading, Design procedure

1 INTRODUCTION

Over the past five years Pres-Lam post-tensioned timber frames have been developed at the University of Canterbury [1] in collaboration with the international research consortium Structural Timber Innovation Company, STIC Ltd. Engineered wood products, such as Glulam and LVL, make it possible to manufacture long span hollow core box sections, which can be used in combination with post-tensioning [2]. Continuous unbonded post-tensioning cables, anchored at exterior columns, clamp beams and columns together, creating moment resisting connections as shown in Figure 1.

2 JOINT STIFFNESS

The stiffness of beam-column connections influences deflections and moment distribution in the frame. Determining the stiffness of post-tensioned rocking connections is complex, in part due to anisotropic timber material properties.

Tests on external post-tensioned timber beam-column connections with draped tendons, as shown in Figure 2 [3], have lead to the development of a design model for the joint stiffness. The model describes the full moment-rotation curve of the joint, as is shown in Figure 3 [4], where the column rotation, joint panel shear deformation, interface compression deformation and gap opening have been taken into account. The gap opening is described by the Modified Monolithic Beam Analogy (MMBA) [5], which has been developed for seismic rocking connections and now has been adapted to gravity frames.

Figure 1: Post-tensioned beam-column connection

Figure 2: Image of beam-column connection test

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¹ Wouter van Beerschoten, Department of Civil and Natural Resource Engineering, University of Canterbury, New Zealand. Email: wouter.vanbeerschoten@pg.canterbury.ac.nz
² David Carradine, Department of Civil and Natural Resource Engineering, University of Canterbury, New Zealand. Email: david.carradine@canterbury.ac.nz
³ Alessandro Palermo, Department of Civil and Natural Resource Engineering, University of Canterbury, New Zealand. Email: alessandro.palermo@canterbury.ac.nz
⁴ Stefano Pampanin, Department of Civil and Natural Resource Engineering, University of Canterbury, New Zealand. Email: stefano.pampanin@canterbury.ac.nz
3 DESIGN PROCEDURE
A design procedure for long span post-tensioned timber frames under gravity loading has been developed. The procedure incorporates the instantaneous Serviceability Limit State and Ultimate Limit State design. Deflections, bending and shear strength are checked according to New Zealand design Standards [6].

4 EXPERIMENTAL FRAME TEST
The frame design procedure will be verified by a full scale experimental frame test subjected to gravity loading, as is shown in Figure 3. Different loading scenarios will be simulated and the results will be compared with the design procedure.

REFERENCES