IX ENCONTRO BRASILEIRO EM MADEIRAS E EM ESTRUTURAS DE MADEIRA
CUIABÁ – JULHO DE 2004

ANALYTICAL MODELING OF NAILED SHEATHING CONNECTIONS IN WOOD SHEAR WALLS

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ABSTRACT: An improved analytical model for nailed connections between sheathing and framing in wood shearwalls is proposed. The proposed connector model is capable of both monotonic and cyclic analysis, may be implemented in a general purpose finite element program or in a specialized structural analysis program, and the overall response does not need to be scaled or adjusted. By way of illustration, a 2.44×2.44 m wood shearwall is analyzed.

Keywords: wood shear walls, analytical modeling, nailed connections

1. INTRODUCTION

In wood housing, lateral forces generated by earthquakes or strong winds are usually resisted by wood shear walls. A typical wood shear wall consists of three primary structural components, sheathing panels, wood framing, and nails. Overall lateral behavior of a wood shear wall is dominated by the individual behavior of nailed connections.

Wood shear walls have generally performed well during earthquakes, in terms of life-safety. Recently, however, the costs of building damage to wood structures have prompted a shift in design emphasis from life-safety to damage control. One way to control damage in wood shear walls is to use a displacement-based design methodology, instead of the conventional forced-based methodology.

A displacement-based design methodology requires detailed information of the shear wall monotonic and cyclic response. Although experimental testing cannot be completely replaced, analytical modeling provides a convenient way to obtain this information.

A nailed connection is usually represented in an analytical model using two coincident nodes, joined using one or more nonlinear springs. Spring stiffness K and force P are defined using a load-displacement relationship derived using a mechanistic approach or an empirical approach.

2. CONVENTIONAL ANALYTICAL MODELS

2.1. Single Spring Model

In the single spring model, a nailed connection is represented using one nonlinear spring. The element stiffness matrix $\mathbf{K}$ is formulated like a "shear element," where the spring stiffness K_r is identical in the global x and y directions.

$$\mathbf{K} = \begin{bmatrix} K_r & 0 & -K_r & 0 \\ 0 & K_r & 0 & -K_r \\ -K_r & 0 & K_r & 0 \\ 0 & -K_r & 0 & K_r \end{bmatrix} \tag{1}$$

Nodal forces $\mathbf{F}$ are assumed to be proportional to the nodal displacements so that

$$\mathbf{F} = \begin{Bmatrix} P\cos\theta \\ P\sin\theta \\ -P\cos\theta \\ -P\sin\theta \end{Bmatrix} \tag{2}$$

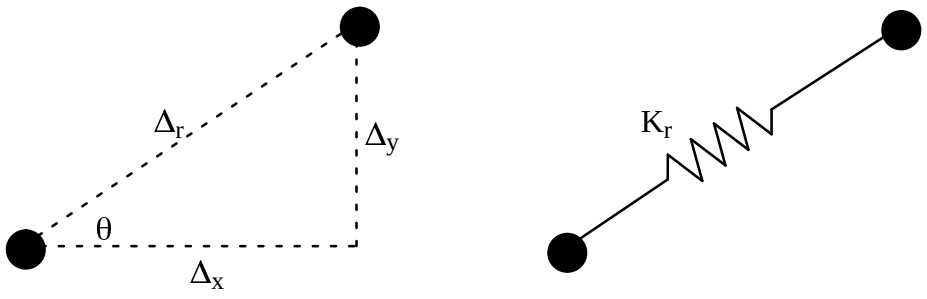

Figure 1 – Single Spring Model.