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Procedia Engineering 12 (2011) 127–132

Engineering Procedia

2011 SREE Conference on Engineering Modelling and Simulation

An Improved Simulation Model of Shear Wall Structures of Tall Building

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Abstract

To simulate shear wall of tall building structures, some kinds of calculation methods towards Multi-Vertical-Line-Element Model are discussed in detail. A more reasonable element stiffness matrix and a improved Multi-Vertical-Line-Element Model are given. Combined with hysteretic axial model and hysteretic shear model, nonlinear analysis of a shear wall is put through. The calculation result indicates that the improved model has relatively well accuracy compared with test result.

Keywords: shear wall; Multi-Vertical-Line-Element Model; nonlinear; simulation

Preface

The nonlinear analysis element model of reinforced concrete wall can be divided into two types: one is based on solid mechanics' microscopic model, the other is macroscopic model with one component as a unit. With the development of computer science , the microscopic method shows its more and more powerful vitality , the analytic range of this method has been developed from structural component to simple structure , and even to earthquake response of three-dimensional structure under reciprocity relationship between bars of the concrete under complex stress state are still in research stage presently , and moreover to analyse the earthquake response of complex structural system is a gigantic numerical

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1877–7058 © 2011 Published by Elsevier Ltd.
doi:10.1016/j.proeng.2011.05.021

work , so this method is limited to do research on structural component or local structure as well as parameter study and the computer analog towards experiment . The macroscopic method is to put a wall limb as a unit by simplification, the unit constitutive relation can be worked out in testing or analytics calculation ways. At present, it is a main serviceable tool of nonlinear earthquake analysis of real complex structure.

For nonlinear analytic macroscopic model of reinforced concrete walls , the development of Multi-Vertical-Line-Element Model (Fig.1) is based on homeostatic beam model and Three-Vertical-Line-Element Model . This model can consider the influence of the movement of wall section's neutral axis and wall axial force on its anti-bending property, solving the compatibility of deformation problem of fringe columns and walls and boards, only needs assured tensile-pressurized and shear hysterias discipline, avoiding the difficulty when using flexural springs to decide flexural hysterias property, so it is an idealized macroscopic model.

Now, the main difference about element stiffness matrix of Multi-Vertical-Line-Element Model lies in the difference of considering shear deformation's magnitude. This text separates shear deformation from none pure bending deformation, only considering the shear deformation to participate in, reflecting the interaction of bending deformation and shear deformation to a certain degree. At last, utilizing existing reinforced concrete tensile-pressurized hysterias model and shear hysterias model to do nonlinear analysis on shear wall.

1. Derive the stiffness of Multi-Vertical-Line-Element Model

Suppose the displacement of wall element ends is $\{d\}^{\mathrm{T}}=\{u_i,v_i,\theta_i,u_j,v_j,\theta_j\}$, among the expression the u_i,v_i,θ_i separately expresses i-end's horizontal displacement, vertical displacement and intersection angle of centered axis, the rest three symbols corresponding to j-end's displacements. The rod ends' force vector $\{F\}^{\mathrm{T}}$ corresponding to displacement vectors, its positive direction shows in Fig.1.

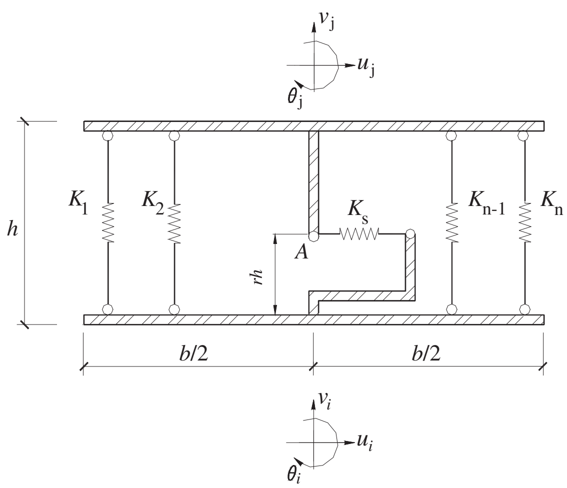

Fig.1 Multi-Vertical-Line-Element Model

Based on small deformation assume, $\sin\theta_i=\theta_i$, $\sin\theta_j=\theta_j$, the vertical bar's i-end's and j-end's horizontal unisonous displacements can be worked out by Diagrammatic Multiplication Method, it includes rigid body displacement and pure bending deformation: