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# ABSTRACTS (PH D THESIS)

## Earthquake Resisting Timber Structure System Composed of Indonesian Engineered Wood Products

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Some special considerations need to be taken care of when designing earthquake-resistant houses for low-income people in Indonesia. When designing tough and ductile earthquake-resisting houses, it is important to pay attention to construction cost low so that the local people could afford to purchase.

### Prediction of Nonlinear Cyclic Behaviors of Shear Wall Composed of Fast Growing Tree Framing and Fiber Cement Board Sheathing

Research on the use of engineered wood product frame as a structural element, and Fiber Cement Board (FCB)-cum-steel nail as sheathing materials for a typical Indonesia house type has been made. A general calculation method for estimating shear performance of nailed on sheathing shear walls has derived. Hence, existing design formula developed for ordinary shear walls with regular nailing patterns cannot be applied in this case. Thus, in order to predict the total behavior of shear walls with nailing patterns either V-shape or arbitrary, modification of existing formula was necessary.

In addition to this, consideration on the nonlinearity due to elasto-plastic characteristics of steel nails is also important. A step-by-step calculation method for predicting shear performance of shear walls with arbitrary nailing patterns was derived. This is followed to looking for the Normalized Characteristic Loop (NCL) model from the experiment (Fig.1) results obtained from the cyclic static test of the shear walls.

These comparisons (Fig.2) might suggest that better prediction will be obtain by paying careful attention to nail shear data to be reflected by insufficient edge distance effect.

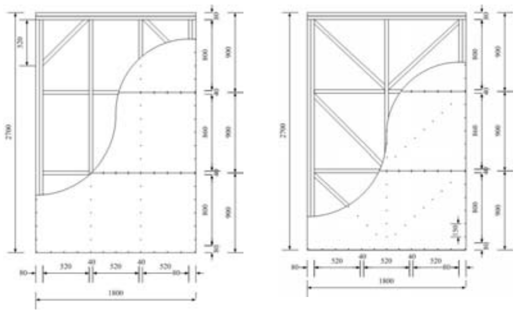

Fig. 1. Conventional shear wall frame (SWC) and Braced Shear wall frame (SWB) specimens.

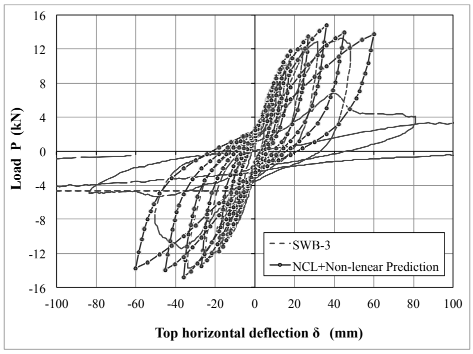


Fig. 2. Comparison between predicted load deformation curve and experimental ones for SWB specimen.

### Dynamic and Static Behaviors of Shear Wall with Openings Composed of LVL and Fiber Cement Board Sheathing

It is also worth noting on the influence of the openings has on a shear wall. To determine the trends in the behavior of shear walls with and without openings, theoretical and experimental studies are conducted through the implementation of cyclic static testing. In this study, as regular nailing pattern was used, hence equations for ordinary design calculations were applied to predict the behavior of shear walls with or without opening when subjected to horizontal push-pull static cyclic load. Shear wall specimen shown in Fig 3.

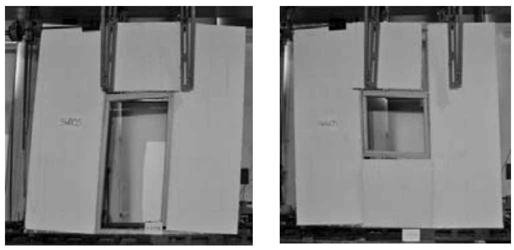

Fig. 3. Door (SWDOS) and window (SWWOS) opening of shear wall specimens.

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All of the specimen test results show a reduction trend in the maximum load that reached by the specimen SWS, SWWOS and SWDOS (Fig. 4.). This happens due to the reducing of the sheathed area of shear wall that significantly contribute to the rigidity level.

Dynamic tests using a small shake excitation machine were also carried out to obtain the relationship between the initial stiffness and natural periods of the shear walls. The natural frequency of wall-type specimens was 4.31 Hz and it was the highest among three specimens as expected. The natural frequency of window-type was 3.86 Hz, it was middle among three, that of door-type was 3.14 Hz, and it was the lowest as expected.

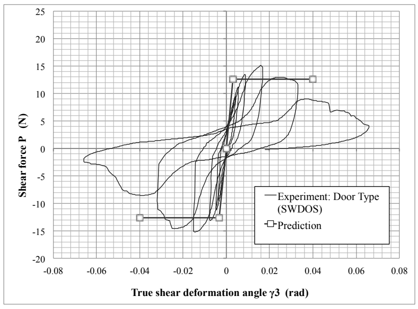


Fig. 4. Comparison between calculation and experimental result on door type (SWDOS)

**Performance of Shear Wall Composed of LVL and Cement Fiber Board Sheathing**

In order to find out whether the strength performance of a simple 3-D test specimen (design based on ordinary design procedure) could meet with the Indonesian standard requirement, both theoretical and experimental studies on a full-size earthquake-resisting house were studied. Comparisons between experimental result and calculated result showed that the mechanical model developed in this study could predict not only the stiffness of the system but also the yielding strength of the simple 3-D test specimen (Fig 5.)

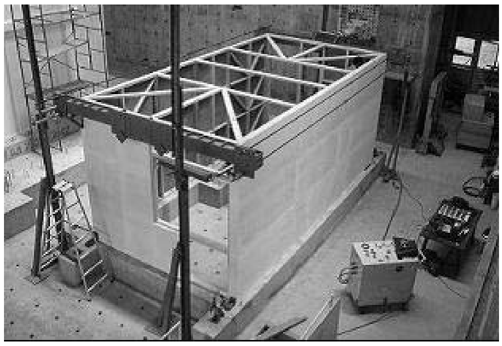

Fig. 5. The Full-scale 3-D specimens for destructive test.

Fig. 6. shows the capacity of the structures and comparisons between the observed load-deformation angle relationship of the 3-D specimen and that predicted by the theoretical models derived previously. The dot-dash line in Fig. 6. indicates the calculated stiffness and yielding load of the sheathing panel predicted by derived equations. The continuous line with diamonds ends indicates the predicted stiffness of the bracing system, which was result from the 2-D FEM analysis. The bold continuous line with triangle ends indicates the total predicted stiffness and the yielding load by summing up two individual components.

In Fig. 6., the horizontal bold line indicates the design value calculated using the Indonesian standard. (Ministry of public works of Indonesia, 2002) Comparing the ultimate strength with the required strength reveals that the safety factor is almost three, this is to be satisfactory for Indonesian standards.

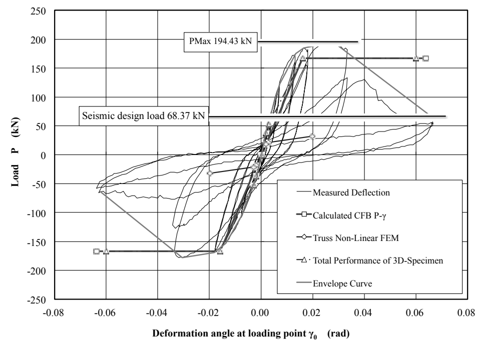


Fig. 6. The comparison between envelope curve and prediction.

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