inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 0.0

DESIGN OF A LIGHT TIMBER FRAMED WALL INCORPORATING STRUCTURAL BRACING

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Keywords:
WALL, SOUND INSULATION, BRACING, TIMBER

ABSTRACT
A lightweight timber framed wall has been developed that incorporates plywood bracing sufficient to meet the structural requirements for a 6 storey high apartment building, while achieving a high airborne sound insulation.

1 - INTRODUCTION

Light timber frame construction of houses is very common practice in New Zealand, however for structural reasons it is not common to use this method for more than 3 storey high buildings. In a recent apartment development it was proposed to build 6 storeys on top of an existing concrete carpark building. Because the existing building had not been designed for the additional weight of 6 levels of apartments it was necessary to build a lightweight structure. A timber frame structure could be designed that would be light enough and would achieve the necessary structural strength, however the techniques used to achieve this were incompatible with the acoustical requirements of the New Zealand Building Code.

2 - DESIGN REQUIREMENTS

The New Zealand Building Code requires building elements between separate tenancies to achieve a laboratory sound insulation rating of at least STC 55, and an installed rating of at least FSTC 50. The 5 point margin accounts for workmanship defects, flanking sound transmission and other site effects such as modal coupling between identical rooms. The structural requirements were for 150 $\times$ 50 mm timber studs, with 12 mm thick plywood bracing rigidly glued and fixed to both sides, (figure 1) while the acoustical requirements are normally achieved with independent wall linings with a large airgap between (figure 2). It was required to have as thin a wall as possible to maximise floor space.

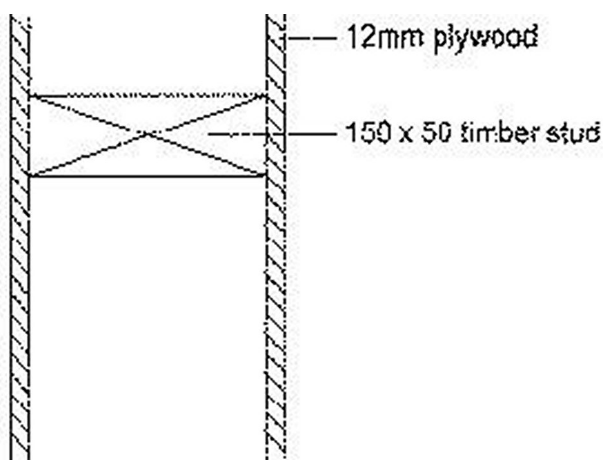

Figure 1: Structural requirements.

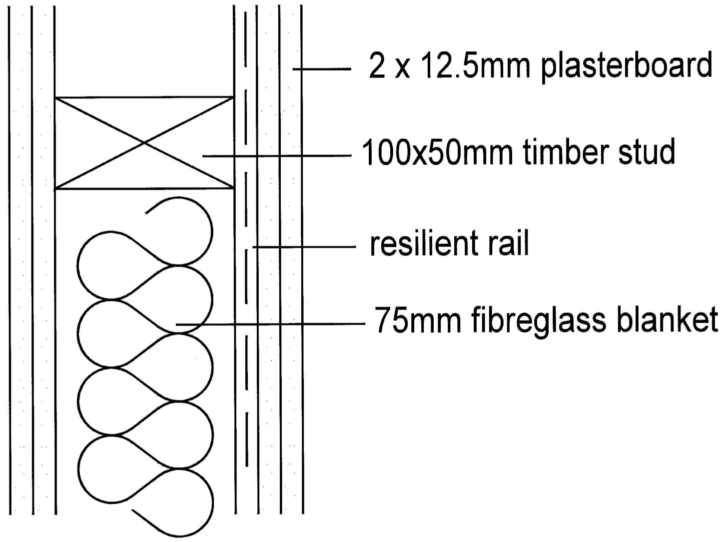

Figure 2: Typical construction to meet acoustical requirements.

3 - DESIGN CONSIDERATIONS

It is well known that to achieve STC 55 it is necessary to use either a single massive wall (for instance 200 mm thick concrete) or to use two much lighter flexible skins separated by a large airgap, with minimal connection between the skins and with an acoustically absorbent blanket in the airgap. Such a design is shown in figure 2. Initially the architect proposed to isolate the wall linings by using resilient rails attached to the plywood (figure 3), however resilient rails used in this way are ineffective because of the coupling between linings due to the thin airgap. In practice an airgap of at least 70 mm is required.

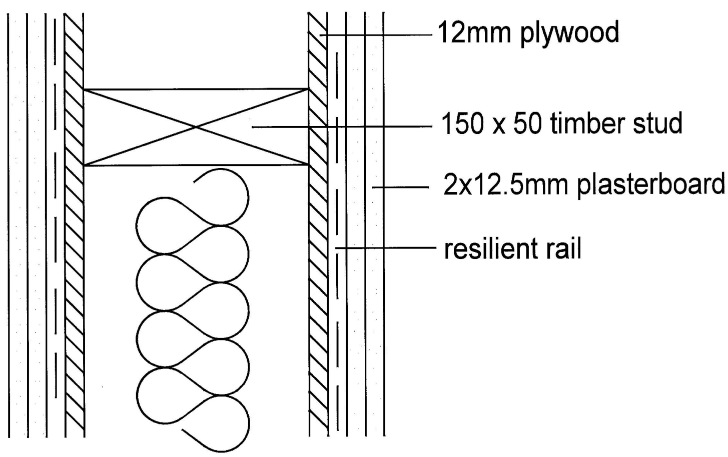

Figure 3: Initial proposal for intertenancy wall.

If the structural design (figure 1) had been accepted as given, and the acoustical requirements to achieve STC 55 had been achieved by adding elements on to the construction the wall would have ended up very wide, and also heavy and expensive. An alternative design was developed (figure 4) in which the structural requirements were in effect turned inside out, by combining both plywood diaphragms into one 17.5 mm thick plywood sheet in the middle of the timber stud (now in fact two 70 $\times$ 35 mm timber studs glued and fixed to the plywood). The isolation of linings was achieved by resilient rails, which in this instance were effective because of the much larger airgap. The overall thickness of the wall is only 238 mm which compares favourably with the width of other lightweight designs without the structural strength.

4 - TEST RESULTS

This design was intended to be a little conservative, so that it would be sure to meet the acoustic requirements, and adequate space, structural requirements and financial resources would be allocated.

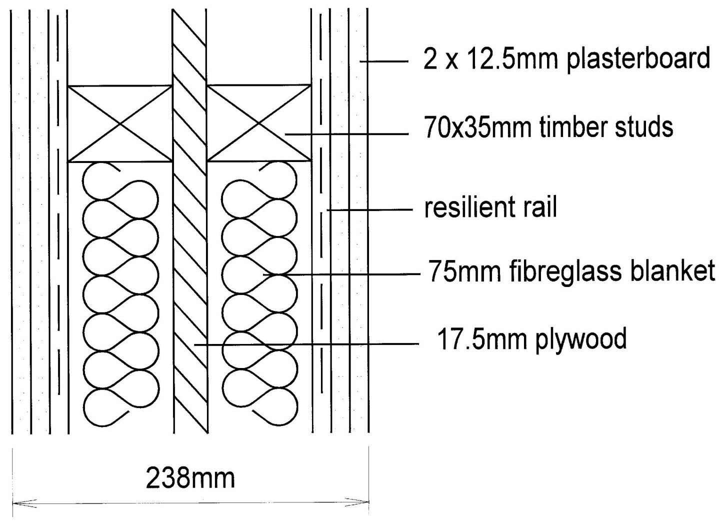

Figure 4: Prototype wall to meet structural and acoustical requirements.

The prototype was then tested in the University of Auckland Laboratory in order to refine the design. With 2 layers of 12.5 mm thick fire rated gypsum plasterboard each side the wall achieved a rating of STC 62. With one layer removed off one side, the rating was reduced to STC 56. The sound transmission loss as a function of frequency for the original design is shown in figure 5. It can be seen that the single figure rating is determined by the bottom two frequency bands (100 and 125 Hz). It can be expected that a larger airgap (by using wider studs) would significantly improve the single number rating.

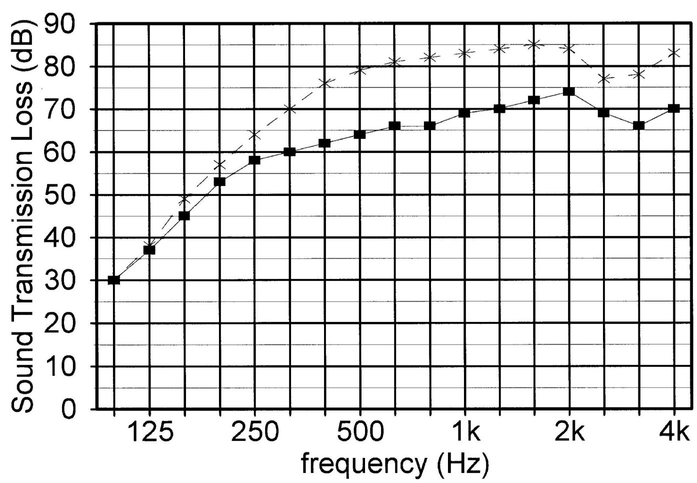

Figure 5: Sound transmission loss of prototype wall; —— measured, —— predicted.

While relatively simple methods are available for accurately predicting the performance of double panels, the methods for triple panels are not so well developed [1]. The methods developed by Sharp were used to predict firstly the transmission loss of 17.5 mm plywood, and then the transmission loss of plywood with 2 layers of plasterboard attached via a resilient rail. The difference between these two results was then added on to the second result. The final result is shown dotted on figure 5. It can be seen that the result is reasonably accurate only for the lowest 3 or 4 frequency bands (up to 200 Hz) and over estimates the performance above that.

5 - CONCLUSIONS

A lightweight wall has been designed and tested that incorporates a high degree of structural bracing while achieving a high sound transmission loss. It has been used to construct a 6 level apartment building that meets the NZ Building Code acoustical requirements.

REFERENCES

1. **B.H. Sharp**, Prediction Methods for the Sound Transmission of Building Elements, *Noise Control Engineering*, Vol. 11 (2), pp. 53, 1978