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ABSTRACTS (PH D THESIS)

Study on structural analysis model for generalization of CLT panel method

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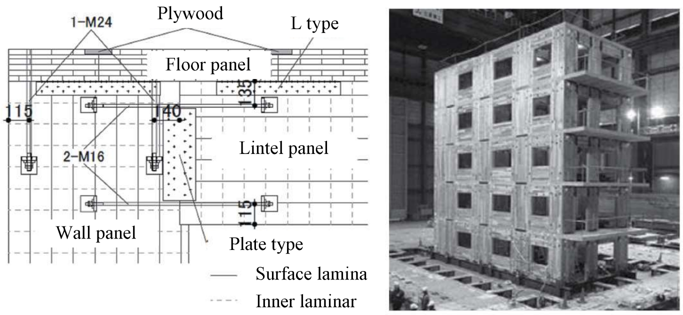
1. Abstract

The purpose of this research is to construct a structural analysis model that can trace experimental results for the purpose of generalizing the CLT panel method in the future. The CLT structure targeted in this study uses a CLT panel with a width of 1 to 2 m for the walls, the hanging walls, and the waist wall that make up the vertical structure, as shown in Fig. 1. The panels are connected to each other and the base frame with pull bolts and screw metal fittings so that they are oriented in the same direction. (hereinafter, "narrow panel frame") It is a frame that transmits bending moment by connecting pull bolts between the upper and lower ends of the wall and between the wall and the hanging wall. The main purpose of this research is to construct an analytical model that can trace experimental results including local stress concentration in such a frame. In addition, conducting a study on a test for the purpose of confirming the influence on the yield strength and rigidity when a small opening is provided, targeting a single panel.

This paper described three types of experiments for the purpose of constructing a structural analysis model of the CLT structure, and explained the construction of the structural analysis model and comparison with the test results in five chapters including the introduction and conclusion.



a) Joints between wall panels　　b) Target building

Figure 1. Target building

Chapter 1 is an introduction, and describes the background and purpose of the research.

Chapter 2 targeted the 1.5-story structure test of the narrow panel frame, and described the construction method and accuracy verification of the structural analysis model.

Chapter 3 targeted the shaking table test of a 5-story CLT structure with a narrow panel frame, and described the construction method and accuracy verification of the structural analysis model, and the seismic design using marginal strength calculation and its validity.

Chapter 4 report the test results and consideration of bending and shearing tests of CLT panels with small openings, which were conducted to confirm the influence of the presence and position of small openings on the yield strength.

Chapter 5 concludes and concludes this research.

2. Proposal of analysis model of CLT structures for narrow panel and accuracy verification intended

Discussed the seismic performance to examine the structural design method of CLT building structures, and conducted a vibration table test to obtain basic data. Compressive failure occurred at corner of CLT wall panel in shaking table test Indication of the construction of the analysis model, tracking behavior when exceeding the test results, as aid in the proposed formula, the construction of the analysis model is useful. In this chapter, we report the construction method and accuracy verification of the analysis model, and subject of the analysis model is 1.5 story of plane specimen.

Using the FEM shell model for the construction of the structural model. It reason for using FEM shell model is capable of confirmation of the distribution of compressive stress in the shaking table in the cause in which the considered panel plane of the crushing of the panel leg seen in destructive nature of the test, also, the contact surfaces of the joint and the panels to each other by making substitutions are arranged on the spring element, because we consider an element comparison of the test results and the analysis results can be achieved.

In this model, CLT panel is an elastic shell elements, the junction is a non-linear spring element. Structural performance of CLT panels and joints were set based on the history of the experimental results. Based on the elements test results, set the properties of each element, you create a structure model of the 1.5-story plane test by the FEM shell model. To compare the analysis and test results of the structural model, we performed the accuracy verification of the structural model, to confirm the validity.

3. A seismic behavior and numerical model of narrow paneled cross-laminated timber building

This chapter presents results of shaking table testing for full-scaled CLT building and a design procedure. The three different systems examined are buildings composed of narrow panels, wide panels with an edge tensile connection, and wide panels with an edge tensile connection for each no-window shear part. The focus of this chapter is the building of narrow panels. This building system is suitable for midrise CLT building with high ductility produced through rocking. The structure was shown to behave well during severe strong motion as specified in the Japanese building standard law and to have survived the 1995 Kobe earthquake despite the occurrence of a compressive rupture in shear walls which are support elements against the vertical load. Story shear capacity calculated from a numerical model and element tests were safely evaluated; but to evaluate the capacity correctly, further research is required in the element and system levels. Though a variety of undetermined issues and challenges remains, the Building Standard Law and Notification for three different CLT construction systems was enforced in April 2016 to ensure the construction of safe CLT buildings.

4. A study on the reduction of proof stress by small opening of equipment for CLT panel

In the case of both narrow panels and large panels, the CLT panel, which is the load bearing wall, may be provided with a small opening for building equipment. In this chapter, in order to confirm the influence of the presence and the position of the small opening on the yield strength and stiffness under the bending test and the shear test of the CLT panel with the small opening were conducted.

Test results and calculated values were compared for the value of the moment of inertia when the specimen was considered as a uniform cross section over the entire length under the bending test. Although the moment of inertia calculated by calculation substantially matches the one obtained by the test result, the moment of inertia I' of the notched portion of the specimen having a shape in which either upper or lower of the specimen is cut out Is overrated. They matched when I' was set to 0.6 times when there was a notch. Although it is necessary to study the adjustment coefficient in the future. If there is a notch on the top and bottom, calculating as a simple cross-sectional defect may result in a dangerous side.

The bending strength was calculated from the bending test results. Although there was no significant difference in bending strength depending on existing or no opening and the position of the opening, the bending strength of the specimen with the opening at the upper end had a value of 1.43 times. In addition, comparing the two specimens in which the opening position is vertically symmetrical, the value of the specimen with the opening on the upper side was somewhat lower. In order to confirm the influence of the fluctuation of the test piece strength on the calculation result, the bending strength was calculated on the assumption that all the test pieces were damaged with the same strain. It almost agreed with the bending strength calculated from the test results. The shear strength calculated from the shear test results does not show large deference due to the existing or no opening and the position of the opening. If the size of the opening this time, it was shown that the shear strength could be obtained by simple calculation without depending on the position of the opening.

5. Conclusion

In this paper, for the purpose of constructing the structural analysis model of CLT structure, mainly reported the construction of the structural analysis model and comparison with the test results for three types of experiments.