STRUCTURAL EVALUATION OF TRADITIONAL TOWNHOUSE WITH TIMBER THROUGH COLUMN IN JAPAN

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ABSTRACT: This paper presents a study of the structural performance of traditional timber townhouses in a historic town in Japan. The aim of this study was to clarify the evaluation method of the structural performance of traditional timber townhouses with through column. The target area has many traditional timber townhouses built in from the middle of 17th century to the early 20th century and these townhouses have few structural walls. In this study, the subject of evaluations was a typical townhouse in this area and earthquake observation, seismic diagnosis and earthquake response analysis were performed. Results of evaluations are compared and it verifies about the difference in evaluation methods.

KEYWORDS: Traditional timber construction, Earthquake observation, Seismic diagnosis, Earthquake response analysis

1 INTRODUCTION

Japan has a long history of earthquakes and timber structures in Japan have suffered great damage caused by strong earthquakes. Old traditional timber structures suffered especially heavy damage. Besides, many of historical towns in Japan have many traditional timber buildings that construction method is same in each area. These traditional buildings often have insufficient earthquake-proof performance. However, if the structural evaluation is suitable for the characteristics of their construction, the technique of earthquake-proofing suitable for those buildings can be examined. Therefore it is important to clarify a suitable evaluation method in each historical area.

2 RESEARCH AREA

2.1 SAWARA DISTRICT

The research area of the present study is the Sawara district of Chiba Prefecture, which is located near Tokyo. The Sawara district is a historical town arranged on the riverside and contains traditional timber townhouse and storehouse with thick walls as shown in Figure 1. They are built in from the middle of 17th century to the early 20th century [1]. In townhouses in this area, the frontage direction of the first floor has few walls and the frames which consist of through columns.

Figure 1: Sawara district

2.2 PREVIOUS EARTHQUAKE DISASTER

On 11 March, 2011, timber structures suffered a great deal of damage due to the 2011 off the Pacific coast of Tohoku Earthquake. This earthquake destroyed or severely damaged 289 houses in the Katori city including the Sawara district. In the Sawara district, many falls of roofing tiles, collapse of mud walls, and foundation damage were observed.

2.3 SUBJECT OF EVALUATION

The subject of the structural evaluation was a traditional timber townhouse. This townhouse was built about 120 years ago. The target house is a building with the typical characteristics of this area. The wall quantity in the

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frontage direction (X) of the first floor was very few and it was not able to satisfy the current standard as shown in figure 2.

4.2 CONSIDERING THROUGH COLUMN FRAME
Instead of with few walls the townhouses of in the Sawara district have many frames which consist through columns in the frontage direction. Therefore, based on the result of static test of previous researches, the effect on the structural performance of the frames was evaluated and seismic capacity evaluation was improved [3], [4].

5 EARTHQUAKE RESPONSE ANALYSIS
The target house was modelled as three-dimensional frame model [5]. The horizontal load-resisting elements of the townhouse are mud walls. The input waves of the analysis were simulated earthquake motions equivalent to design earthquake ground motion based on Japanese Code. Parametric study was performed on the reducing rate for strength due to horizontal diaphragms and beam-column joints.

As a result, although response displacement was large, it did not collapse. Therefore, the target townhouse holds the minimum earthquake-proof performance.

6 CONCLUSIONS
1. In the frontage direction (X) of the first floor, the townhouse does not have structural walls nevertheless there are some earthquake-proof performance.
2. Considering the structural performance of through column frame, the townhouse in this area can be evaluated appropriately.

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REFERENCES