SEISMIC DESIGN METHOD OF HYBRID STRUCTURE OF WOOD AND RC

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ABSTRACT: Seismic design method of hybrid structure of wood and RC is discussed. Although the structure mainly consists of wood, RC core parts are partially involved. Since these parts have quite different vibration properties, reasonable seismic force distribution is proposed based on eigen value analysis.

KEYWORDS: Hybrid structure of wood and RC, Vibration property, Seismic force distribution

1 INTRODUCTION

In Japan, construction of wood structures for public buildings is encouraged for environmental reason. Nowadays, large wood buildings are built with the help of hybrid structure. For example, low rise large floor wood building has core parts which are usually reinforced concrete structure as shown in Figure 1. Structural design is difficult without core parts because wood building has flexible floor diaphragm and requires a lot of shear walls. Therefore, it is important to evaluate vibration properties of the horizontally combined structure and to propose simple seismic design method.

Figure 1: An example of hybrid structure of wood and RC

2 PROTOTYPE OF HYBRID STRUCTURE

Architectural Institute of Japan(AIJ) provided a prototype of hybrid structures of wood and RC in order to show the procedure of structural design. Figure 2 is the typical floor plan. It intends three stories school buildings having RC core part in X4 to X5 and X11 to X12.

Figure 2: Floor plan of prototype building

3 VIBRATION PROPERTIES

Eigen value analysis is carried out using simple shear spring model as shown in Figure 3. Properties of the model are shown in Table 1. The characteristics of important modes are discussed here. Two pairs of “wood part dominant modes” and “core part dominant modes” are obtained as shown in Figure 4. The most important thing is that wood parts and core parts do not act in the same modes. Additionally, Natural periods of wood and core part dominant modes are quite different.

4 DISCUSSION OF EARTHQUAKE RESPONSE

Earthquake response of the hybrid structure is discussed using spectral method. Pseudo acceleration spectrum as shown in Figure 5 is assumed, which is modeled on Japanese seismic code for allowable stress design. Table 2 shows contribution of each mode to base shear force, floor shear force and floor moment at A and B part of 2nd floor (see Figure 2). Most of base shear force is derived from 1st,
2nd, 3rd, 33th, 34th and 35th modes. These are the most dominant modes of wood parts and core parts. However, floor shear force and floor moment are derived from 1st, 2nd, 3rd, 5th, 9th, 10th and 12th modes, which are wood part dominant modes. Therefore, stresses of wood part elements are likely to be calculated using wood part dominant modes.

![Vibration analysis model](image)

**Figure 3: Vibration analysis model**

**Table 2: Stiffness of shear springs (Unit: kN/cm)**

<table>
<thead>
<tr>
<th></th>
<th>Wood</th>
<th>RC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral</td>
<td>Floor 135</td>
<td>Floor 28200</td>
</tr>
<tr>
<td></td>
<td>Interior wall 97.2</td>
<td>3F frame 27430</td>
</tr>
<tr>
<td>Vertical</td>
<td>Exterior wall 256.2</td>
<td>2F frame 40550</td>
</tr>
<tr>
<td></td>
<td>Vertical 1F frame 54170</td>
<td></td>
</tr>
</tbody>
</table>

![Pseudo acceleration spectrum](image)

**Figure 5: Pseudo acceleration spectrum**

**5 CONCLUSIONS**

In this paper, prototype of hybrid structure of wood and RC was shown, and basic vibration properties were discussed. We found that wood parts and core parts do not act in the same modes, and most of stresses of wood part elements are derived from wood part dominant modes.

**REFERENCES**