Introduction

Japan is a country that during the last half century has been subject to a series of natural disasters, creating some of the worst residential crises in recent years. This experience, added to Japan’s highly developed industry has enabled it to develop a Standard Prefabricated Emergency Temporary House that is practical in its speed of production and in the vast amount it can be produced. In spite of this, many shortcomings to this system have been pointed out. In recent years, a push for the development of alternative methods of temporary housing has led to a limited employment of timber based temporary housing units that have tried to overcome the Prefabricated type’s limitations. This thesis provides a physical description of the Standard Prefabricated Emergency Temporary house and three timber alternatives; The Machined Log House, The Itakura Wood Panel System House, and the Timber Frame House. The main objective is to understand the currents state of temporary housing in Japan, as well as to draw out a set of advantages and disadvantages to each housing strategy, with the intention of establishing a better knowledge basis for future temporary housing efforts.

Methodology:
A group of four case study housing types, including the Standard Prefabricate House was established. The case studies chosen were required to fulfill the following criteria:

a) Produced beyond the prototype phase
b) Have official permission at a local and prefectural level to be mass produced
c) Currently occupied
d) Are either Prefabricated or Timber based

The terms of comparison for each of the case studies will be based on:

- Cost
- Overall design and functionality
- Material use
- Life Cycle Analysis

The comparison is established on information found in existing publications, as well as interviews. Information for the Overall design and functionality category was obtained from opinion-based surveys delivered among four exemplary temporary emergency settlements of the housing types studied. Out of 300 submitted the answers from 87 returned surveys (29%) were recorded.

Background On Temporary Housing in Japan

This section aims to illustrate the Basic Law of Measures Against Disaster and Disaster Relief Act of 1947, and how they were put into action by prefectural after the Great Hanshin-Awaji and Great East Japan Earthquakes. A description on the agreements made between the Japan Association of Prefabricated Constructors (JAPC) and prefectural governments, leaving only 14.94% of the total housing production to local contractors, according to Brassor and Tsubuku, (2011).

Finally, a description is made on the demographics of transitional settlements, in which 40% of temporary houses accommodated elderly families by themselves and half of them lived alone”, after the Great Hanshin-Awaji Earthquake, (Tanida, 1996). Two years later “49% of these houses were occupied by families over 65 years old (…), many of which (up to 70 percent)
had a yearly income of less than 3 million yen prior to the earthquake”, (Koshiyama, 2007), making their access to permanent housing very difficult. The self-help philosophy encouraged by the government, and the lack of attractive options for residence exacerbated

The Standard Prefabricated Temporary House and Alternative Temporary Housing Description

The second section offers a description of the physical conditions of the existing temporary housing types chosen for study in this thesis based on the following:

- General Exterior Appearance
- Materials and Structure: Foundation/ Frame/ Walls/
- Roof
- Interior Dimensions
- Interiors Layout Description and Materials

What is most evident from the descriptions made of the various interior layout is that only small variations in interior distribution have been made between all models except the Itakura Wood Panel System housing, which possesses different location of areas, as well as an added loft space. Interior differences between the rest of the housing models were mainly seen in the use of partitions between rooms, some of which were mobile, as seen in the cases of the Machined Log and Timber Frame types. Ceiling heights are also different between the different houses, but this is only clearly visibly in the Itakura type. More conspicuous differences between all houses may be seen in the location of wall openings towards the exterior, as well as the availability of outdoor spaces such as larger eaves that form Engawa, and the design of the wind lock and genkan.

<table>
<thead>
<tr>
<th>Table 1. Temporary Housing Types by Characteristics</th>
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<tbody>
<tr>
<td>Standard Prefab</td>
</tr>
<tr>
<td>1DK (19m²)</td>
</tr>
<tr>
<td>2DK (29.7m²)</td>
</tr>
<tr>
<td>3K (39.6 m²)</td>
</tr>
<tr>
<td>Foundation: Pine piling 90mm diam. 1000 mm length</td>
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<tr>
<td>Walls: Steel sheet Covered sandwich paneling. Light gauge steel frame</td>
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<tr>
<td>Roof: Galvanized Metal roofing Plasterboard</td>
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<tr>
<td>Ceiling: Plasterboard t=9.5mm</td>
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<tr>
<td>Floors: Wood composite, wood flooring</td>
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Images 1 to 4 in clockwise order: Prefabricated, Machined Log, Timber Frame and Itakura housing types.
Images 5 to 8 in clockwise order: Prefabricated, Machined Log, Itakura and Timber Frame housing plans.
Comparison

This section establishes a comparison between the temporary housing types previously described. When comparing the costs per unit, the thesis reveals that there is not a great disparity among any of the housing types studied, with a price of around 5 million yen per house being the norm.

Greater differences could be appreciated in the rest of the comparison categories. For instance, when contrasting the Overall design and functionality of housing types the survey conducted produced results that show a definitive disparity in performance between the prefabricated type housing and the timber based alternatives studied, with the former performing distinctly more poorly. The causes for these results could basically be attributed to either the differences in materials used, or those found in design in terms of openings in facades, wall composition and protection against sunlight such as eaves.

The negative issues most visibly shared among all types of housing studied were mainly three:

1. Sound insulation
Problems with noise coming from next door appear to originate both in the general layout of housing
settlements, with adjoining units sharing separation walls, and also due to the lack of sound proofing materials.

2. Thermal comfort
Thermal discomfort was constantly mentioned in the open comments collected in the survey. Possible causes were indicated as being high thermal conductivity in the materials used or lack of proper protection against the cold.

3. Lack of space for every day life activities
Lack of storage is evident when considering that assigned closet area in all of the housing types comprises only 3 percent of the total floor surface. Only the Itakura type housing offered a multiple purpose space in the form of a loft to address this situation.

The conclusion for this section is that the varied use of materials does make a difference in internal environment conditions. The use of timber vs. metal and synthetic materials does make a difference in user opinions, but only if paired with a well-developed design.

Conclusions
Beginning with policy, it became apparent that the current method of temporary housing owes its manner of being to a government philosophy of massive, rapid and standardized emergency housing that is practical but at the same time just part of a transitory measure of relief responsible a lack of participation of local industry, generating a diminished influx of permanent resources into the local economy. Second, the standardization of housing gives way to units that are not adequate for local living conditions, resulting in a deteriorated quality of life for the residents. The participation of researchers, architects and regional builders results in more locally minded, higher spatial quality housing, where better resource management is more evident. The polls on interior environments support this assertion, and it is concluded that the use of timber does make a significant improvement over materials used in prefabricated housing, but that the use of material is just as important as the quality of design.

Based on the research carried out, it is recommended that future temporary housing design contemplate:

- The scale and location of the disaster
- The existence of local resources and industries that may be capitalized on
- The best materials to use for the environment in question
- The participation of designers, researchers and experienced local builders
- Extending the lifecycle of buildings and materials
- The characteristics of the population
- The provision of comfort for occupants

References