The design examples of wooden building to be constructed in the region where tsunami attack may occur

TSUCHIMOTO, Takahiro (DAg): Head
Evaluation System Division, Research Center for Land and Construction Management

(Keywords): depth of water coefficient, tsunami refuge building, inundation height, wave pressure distribution, tsunami prevention regional construction, displacement, buoyancy, topple down

1. Background of deliberation

Great many wooden buildings suffered damage by the tsunami triggered by the 2011 Great East Japan Earthquakes. The results of comparison made with its actual damage situation[(1)] and external force and proof stress of wooden buildings which were worked out from the tsunami refuge building guideline does not agree each other[(2)]. So an appropriate depth of water coefficient meeting the damage situation was calculated which suggested the possibility to set in between 1.0 and 1.5[(3)] .

On the other hand, in the regions where they have suffered devastating damages by the tsunami, majorities are drawing up their reconstruction plan to move houses to the high ground, but there still is a large number of people who would prefer to live in a place where they can view the seashore. Meanwhile, for the regions where they are likely to be hit by the tsunami triggered by the predicted Tokai-Tonankai earthquake, the proactive program would become necessary.

And so, the deliberation of drawing design methods regarding the wooden buildings and wooden tsunami refuge buildings to be constructed within the regions of possible tsunami attack.

2. Calculation of the external force

Wave pressure and wave power of tsunami was calculated based on the wave pressure distribution which is the product of depth of water coefficient and hydrostatic pressure set in the tsunami refuge building guideline[(4)]. For the depth of water coefficient, figure 1.5 was used which was drawn from the Notification of the Ministry of Land, Infrastructure, Transport and Tourism 2011, No. 1318, based on the Act regarding tsunami prevention regional construction, in which it is applied to the locations where reduction of wave pressure blocked by other facilities is expected and at the same time more than 500 meters away from the seashore and rivers.

Openings of the building are presumed be damaged, and buoyancy resulting from dead air space between the ceiling height of the floor lower than inundation height and inundation height whichever is lower and the bottom end of the partition wall was also considered. The fixed load of the building is reduced by specific gravity of water and the movable load was not included in the weight of the building because they would be washed away. Other issues like consideration of pressure-resistant materials and floating wreckage, were made in accordance with the tsunami refuge building guideline[(5)].

3. Verification of wooden building proof stress

With regard to the horizontal load which affects to the parts of the wooden building, shear proof stress of the building frame, tension proof stress of joint parts and shear proof stress of anchor bolts were verified.

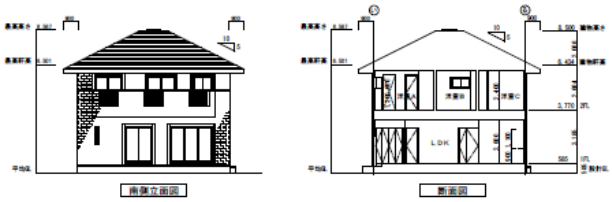
The ultimate shear proof stress of the wooden building was calculated using the figure 1.5 times of allowable proof stress.

Also toppling down and sliding of the whole building against horizontal load were verified. Furthermore, tension proof stress of joint parts and anchor bolts against buoyancy were verified. See document (5) for more detail.

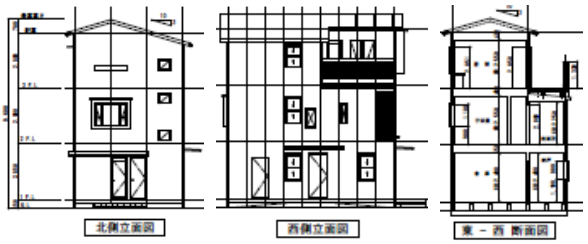
4. Design examples

Followings illustrate the outlines of design examples.

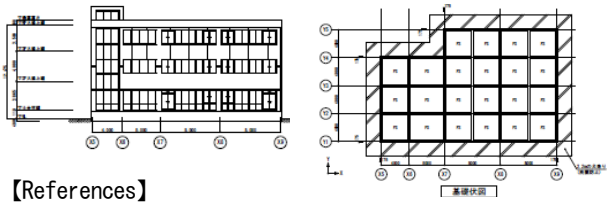
4.1 Two-story wooden house (inundation height: 2 meters, depth of water coefficient: 1.5)



4.2 Two-story wooden house (inundation height: 3 meters, depth of water coefficient: 1.5)



4.3 Wooden tsunami refuge building (inundation height: 4 meters, depth of water coefficient: 1.5, refuge floor: roof terrace (4th floor)))



【References】

(1) National Institute for Land and Infrastructure Management document No. 636, Building Department document No. 132, The 2011 earthquake off the Pacific coast of Tōhoku, (flash) (the Great East Japan Earthquake) http://www.nilim.go.jp/lab/bcg/ siryou/tnn/tnn0636.htm , http://www.kenken.go.jp/japanese/contents/ topics/20110311/0311quickreport.html, 2011.

(2) TSUCHIMOTO Takahiro, NAKAGAWA Takafumi, ARAKI Yasuhiro, TSUDA Chihiro: " Damage to Wood Buildings during The Great Tohoku Earthquake Part 3- Damage due to tsunami", 11th Proceedings of World Conference on Timber Engineering, 2012.

(3) TSUCHIMOTO Takahiro, NAKAGAWA Takafumi, ARAKI Yasuhiro, KAWAI Naoto: "Damage Due to Tsunami and Tsunami Resistance Performance of Wood Houses during The Great Tohoku Earthquake", Proceedings of 15th World Conference on Earthquake Engineering, 2012

(4) Cabinet Office: The guideline regarding tsunami refuge building http://www. bousai.go.jp/oshirase/h17/tsunami_hinan.html, 2005.6

(5) The Japan Building Disaster Association: Commentaries regarding the structural requirements for the tsunami refuge building, 2012 . http://www.kenchiku-bosai.or.jp/ seismic/tsunami_text.html