RESPONSE ESTIMATION METHOD OF REINFORCED CONCRETE BUILDINGS DUE TO WATERBORNE DEBRIS IMPACT LOADS

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After the 2011 Great East Japan Earthquake, tsunami loads were evaluated based on the damage observations [1], and a structural design code for tsunami evacuation buildings was established [2]. However, impact loads due to waterborne debris were not considered quantitatively in the code. Waterborne debris were reported to cause damage to buildings [3] (Figs. 1 and 2), and design methods against the debris impact loads are therefore currently in urgent need for designing safe tsunami evacuation buildings.

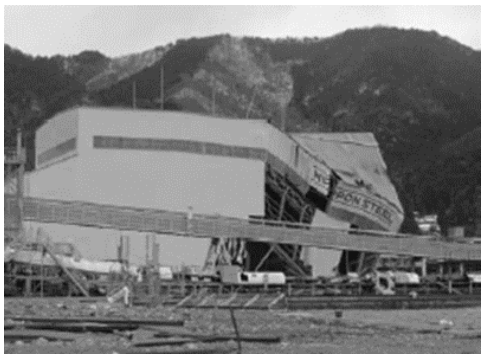

Figure 1. Building collapsed by ship collision (Kamaishi city, 2011) [3]

Figure 2. Stranded cargo ship collided with building (Kamaishi city, 2011)

In the previous researches, impact loads due to waterborne debris have been examined through experiments [4], but the building responses were not focused in the discussions. To understand the building responses due to the debris impact loads, in this paper, impact loads due to ships and shipping containers are firstly defined as a rectangular pulse, based on the studies to evaluate collision strength of a ship's bow [5] and those to obtain a time history of an impact load due to a shipping container [6].

The defined loads are secondly imposed to a particular six story reinforced concrete building designed to an expected tsunami wave load, and its elastic responses are computed by applying modal analyses. Because the building response due to an impact load is significantly affected by the impact duration, the response characteristics are parametrically analyzed to different impact durations. It is then found that the time, either before or after the termination of the loading, when the story drift reaches its maximum value depends on the impact duration. Two simplified approaches are therefore proposed considering impact duration to roughly estimate the maximum story drifts due to the impact loads.

As a result, the estimated maximum story drifts are found in a good agreement with those computed by modal analyses (Fig. 3).

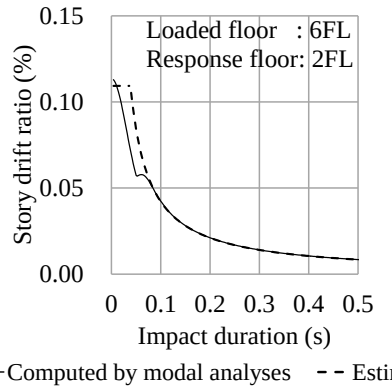

Figure 3. Example of estimated maximum story drifts

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