Collaboration between meteorology and wind engineering on development of Japanese Enhanced Fujita Scale

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Tornadoes are infrequent, small-scale brief phenomena whose development is difficult to identify with ordinary weather observation network resources. It is necessary for identification of such small-scale phenomena to investigate the tornado damage in order to estimate the phenomenon type and its intensity. The Japan Meteorological Agency (JMA) dispatches the JMA Mobile Observation Team (JMA-MOT) to tornado disaster sites, and they investigate damage for identifying the information on the phenomenon and its intensity scientifically (referred to here as rating). The Fujita scale has conventionally been used to rate tornado intensity.

The Fujita scale was developed in 1971 by Dr. Fujita at the University of Chicago and has been commonly adopted in the United States and worldwide because it can easily rate tornado intensity by classifying it into six categories, F0~F5, based on damage to buildings and other structures.

But the Fujita Scale has a limit to the accuracy of rating because of some issues: correspondence between damage descriptions and wind speeds has not been adequately verified, the damage indicators (DI) are limited, and so on. In response to these issues, the Enhanced Fujita scale, which provided the wind speed estimation based on 28 DIs distributed widely in the United States and their degrees of damage (DODs), was developed in 2006, and was adopted by the National Weather Service in 2007.

In Japan, after the tornado on May 2012 which caused severe damage in several cities, such as Tsukuba in Ibaraki prefecture, various measures were proposed by not only JMA but also by whole Japanese government ministries and agencies. As a part of these measures, the Japanese Enhanced Fujita scale, whose DIs were defined from buildings and other structures commonly found in Japan, was formulated on the basis of cutting-edge expertise in wind engineering with reference to the Enhanced Fujita Scale in the United States.

Based on the examination of “the Advisory Committee for Tornado Intensity Rating” (chair: Yukio Tamura, professor emeritus, Tokyo Polytechnic University) consisting of wind engineering, architecture, forestry and meteorology experts, JMA has developed and released “Guidelines for the Japanese Enhanced Fujita Scale” in Dec 2015.

The characteristics of the Japanese Enhanced Fujita scale are as follows: (1) Introduction of damage indicators and degrees of damage corresponding to buildings and other structures commonly found in Japan; (2) Determination of wind speeds (rounded to multiples of 5m/s) corresponding to damage indicators and degrees of damage; (3) Unification of wind speeds into three-second average values; (4) Correspondence of wind speed ranges to classes (JEF0~JEF5) in consideration of statistical continuity with the Fujita scale. These advantages enable more accurate estimation of wind speed than rating using the

conventional Fujita scale and it also became easy to compare tornado cases with ones in the past.

The formulation of the guidelines was examined with reference to the expertise of many researchers participating in a special research project titled Cooperative Study on a New Scale for Rating Tornadoes in Japan (research representative: Yasuo Okuda, Director, Department Structural Engineering, Building Research Institute) conducted by the Wind Engineering Joint Usage/Research Center with funding from the Ministry of Education, Culture, Sports, Science and Technology. This formulation could not be achieved without the promotion of research by close collaboration between wind engineering and meteorology in this project. It also produced DIs and DODs to be applied to wind speed rating without specialized knowledge of engineering, considering JMA staffs survey destructiveness at disaster sites.

JMA has implemented Japanese Enhanced Fujita scale from Apr 2016, and rated 44 cases (tornadoes, downbursts and other hazardous winds) until the end of Dec 2016. The rating results are opened on tornado database of JMA web page. 30 types of buildings and other structures are used as DIs now, but as the number of rating cases at disaster sites increased during the implementation, it has become clear that new DIs and/or DODs need to be added. In response to these issues, the related research keeps on being carried out under the collaboration between wind engineering and meteorology in order to make the Japanese Enhanced Fujita Scale easier to use.

Keywords: Tornado, Wind Disaster, Damage Survey, Wind Engineering, Interdisciplinary cooperation

Approach to the 2016 Kumamoto Earthquake from Quaternary Study

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Some of fields of Quaternary studies, such as paleoseismology and alluvial sediments, are deeply related to evaluation of natural disasters. In the case of the 2016 Kumamoto earthquake, Activities of Aso volcano was also one of the most important elements.

The 2016 Kumamoto earthquake (M 7.3) was generated on the Futagawa fault, which located on the southeastern margin of the Beppu-Shimabara graben. Behavior of this fault had been evaluated based on the tectonic landforms and paleoseismological surveys and it was consistent with the 2016 event.

Study on the alluvial plain provides important information for the evaluation of the strong ground motion caused by earthquake. In Kumamoto plain, there are several layers of lava and welded pyroclastic flow deposits from Aso caldera and other volcanoes. These volcanic layers will influence on the propagation and amplification of seismic ground motion, whereas it is also useful to estimate the subsidence rate of Kumamoto plain.

Tephras from Aso are also sources of the natural disasters. It was reported that a tuff layer in the soil was a surface of slide on the slop. Many landslides occurred on steep slopes on the scoria cones and caldera walls.

Keywords: Quaternary study, 2016 Kumamoto earthquake, active fault, volcano, geology of alluvial plain, natural disaster

How to optimize the response of the earth science commnity toward severe hazards

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Upon the occurrences of large-scale natural hazards, earth science communities and individuals are urged to respond to the hazards and disasters. In order to optimize our response to them, it is necessary to review our reactions and think about better ways for cooperative research.

Keywords: natural hazard, hazard response, post-disaster survey

