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USING THE IMPROVED MAGNITUDE METHOD TO FORECAST DAMAGE LENGTH OF MARITIME STRUCTURES CAUSED BY TYPHOON 9918

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In 1999, Typhoon 9918 struck Kyushu Island, which is located in Western Japan. During the strongest stage of the typhoon, the central pressure was 935 hPa and the maximum wind speed was 46.3 m/s near the center of the typhoon at a latitude of 30° N. The radius of wind area of over 25 m/s was 200 km. The maximum storm tide was over 2 m along the coast of Kumamoto Prefecture on Kyushu Island. Due to the storm surges and wind waves the typhoon caused enormous damage to maritime structures, including breakwaters, sea walls, sea dikes, jetties, wharves, etc. The coastlines in this prefecture are complex. It faces open and closed seas. Each coastline has different topographical characteristics. The coastline is divided into 4 coastal areas.

In this paper, the damage length of maritime structures along the coastline caused by Typhoon 9918 is estimated by using the so-called Magnitude Method. The Magnitude Method is defined based on the maximum wind speed near the center and the size of the typhoon at a latitude of 30° N.

The maximum wind speed and the size of strong winds of a typhoon are closely related to the total typhoon energy. Wind waves gain its energy from the typhoon energy with an increase in height and period as the wind affected area increases. The size of the typhoon is defined as the area for which the wind speed is greater than 15 m/s. The intensity of the typhoon is defined as the area in which the maximum wind speed occurred. The typhoon size is divided into 8 categories, while the intensity is divided into 10 categories. The magnitude of a typhoon is defined by a combination of the rank of its intensity and its size. The magnitude is categorized from 1 to 17. The damage length is defined as the alongshore distance along which damage is caused to structures by a typhoon. The damage length caused by each typhoon is divided by the total damage length by 75 typhoons in each coast. The obtained value is called smoothed length of damage, and indicates relative weakness of each coast for each typhoon.

From a relationship between the magnitude of typhoon and the smoothed length of damage, an index of vulnerability of each coast for the same rank of typhoon magnitude is defined. The index of vulnerability is ranked from 1 to 6 in Figure 1, and is called “sensitivity values” of typhoon for the magnitude. This sensitivity value indicates the index of vulnerability of the coast for each typhoon. The Improved Magnitude Method utilizes an index of vulnerability of a coastline for a typhoon passing a specified path, which is derived from the damage by all 75 typhoons during the past 25 years (R. Hashimura, 2010).

The damage length is estimated as follows: The path of Typhoon 9918 is determined from the location and the moving direction of the typhoon at a latitude of 30° N. The vulnerability index of maritime structures, which is shown in Table 1, is determined based on the path of the typhoon and coastline. The value of the smoothed damage length is calculated by using the index of vulnerability and the magnitude of Typhoon 9918 at a latitude of 30° N. The value of the damage length by Typhoon 9918 at the coast is estimated by substituting the value of smoothed damage length and the total length of damage by all 75 typhoons during the past 25 years at the same coast.

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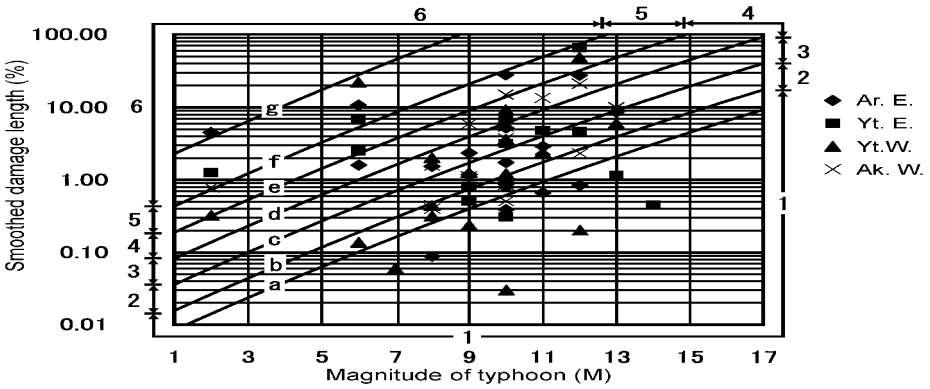

Figure 1 Magnitude and smoothed length of damage.

Table 1 Maximum sensitivity values

Path No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Ar. E. (Closed)	1	3	5	4	3	4	1	6	0	2	6	0	0
Yt. E. (Closed)	0	1	4	5	3	6	0	5	0	3	6	0	0
Yt. W. (Closed)	1	3	4	5	1	1	0	6	1	2	5	0	0
Ak. W. (Open)	4	5	3	4	3	2	2	6	0	4	6	0	0

The conclusions show that the Improved Magnitude Method is upgraded in comparison with Magnitude Method and it will be used to estimate the damage length of maritime structures that will occur along the coast before a typhoon strikes. The forecasting method reported here will be used for the purpose of coastal management in disasters prevention works.

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