BREAKING WAVES HEIGHT FORECASTING AT THE SHORELINE OF PANCENG SUB-DISTRICT GRESIK DISTRICT

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INTRODUCTION

Shoreline is well-defined as a line where the edge of the land and the sea met. Various amount of shore construction was built around the shoreline. The safety of surrounding community near the shoreline should be considered before the government planning on near shore and shoreline facility. Therefore, breaking waves height become important because of the impact that it brought to the shoreline, such as the destructive energy that breaking waves generates which would wipe anything that existed alongshore.

Using the data collected from BMKG (Meteorology, Climatology, and Geophysics Council), maximum wind stress at the Panceng Sub-District was 17.2 m/s. Average effective fetch at Panceng Sub-District was 331.68 km with 5 m significant wave height and 11.2 s period. Breaking wave height at Panceng Sub-District is 5.5 m.

Keywords: breaking waves height forecasting, shoreline

Abstract

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RESEARCH METHODS

In order to forecast a breaking waves height in this paper, there is several step [7][8]:

1. Wind

Data used in this paper are collected from BMKG (Meteorology, Climatology, and Geophysics Council) official website and was a maximum wind stress from year 2017-2021. The data provided was measured in Tuban Meteorology Station (-6.82290 latitude, 111.99177 longitude) and must be corrected with these few stages.

a. Height Correction [9]

\[ U_{(10)} = U_{(z)} \left( \frac{10}{z} \right)^{1.7} \]  \hspace{1cm} (1)

where:

\( U_{(10)} \) = wind speed at 10 m height
\( z \) = elevation where the wind measured

b. Stability Correction [10]

\[ U = R_T U_{(10)} \]  \hspace{1cm} (2)

where:

\( R_T \) = stability correction factor (1.1)

2. Measuring Location Correction [11]

\[ U_{W} = R_L U_{L} \]  \hspace{1cm} (3)

where:

\( U_{W} \) = wind speed above the sea water
\( U_{L} \) = wind speed measured at land
CI-TECH Journal/Syah Putra Aira Loka1, Iwan Wahjudijanto2, Minarni Nur Trilita3/Vol. 02/No. 02/2021

\[ R_L = \text{coefficient gained from the chart below} \]

Figure 1 Relationship between wind speed on land and wind speed over sea chart
(Source: Triatmodjo (1999))

d. Wind Stress Correction [12]
\[ U_A = 0.71 \ U^{1.23} \]  \hspace{1cm} (4)
where:
\[ U = \text{wind speed} \]
\[ U_A = \text{corrected wind speed} \]

2. Fetch
Fetch length is restricted by the form of the sea border with the land around the sea that will be researched with the same wind direction and various direction around it [13]. Effective average fetch calculated using following equation.
\[ F_{eff} = \frac{\sum (X_i \cos \alpha_i)}{\sum \cos \alpha_i} \]  \hspace{1cm} (5)
where:
\[ F_{eff} = \text{effective average fetch} \]
\[ X_i = \text{the i-th fetch sections length, appraised from the measured point until the land at the border of the fetch} \]
\[ \alpha_i = \text{Angle of wind direction deviation from the i-th fetch segment, from 0\(^\circ\) to 42\(^\circ\) in 6\(^\circ\) increments on each side of the wind direction} \]

3. Deep Sea Wave Forecasting
Significant wave height (\(H_s\)), wave period (\(T_m\)), also minimum wave duration value could be obtained by using the Deep-sea significant wave prediction nomogram with effective average fetch (\(F_{eff}\)) and wind stress factor (\(U_A\)) value that been calculated before [14].

4. Breaking Waves Height
Breaking waves was a complicated system. Even in a few moments earlier the waves broke, the form of the waves is not sinusoidal again. The energy gathered from the wind would be reduced when the waves broke. Part of the energy were repressed into the ocean and the quantity depends on the slope of the coast, the smaller the angle of the beach slope, the smaller energy is reversed. Most energy reduced as heat in mixing small scale of water foam and sand [15]. Breaking waves height (\(H_b\)) gained from the chart below.

Figure 2 Deep sea significant wave prediction nomogram
(Source: Triatmodjo (1999))

Figure 3 Breaking wave height determination chart
(Source: Triatmodjo (1999))

RESULTS AND DISCUSSIONS

Refers to wind data collected from BMKG, it can be seen that the dominant wind direction is from the northeast, thus, the wind direction used for the next calculation is from the northeast with a maximum wind speed of 10 m/s.

\[ U_{(10)} = 11.04 \text{ m/s} \]
\[ \text{U} = 12.14 \text{ m/s} \]

\[ \text{U}_W = 13.35 \text{ m/s} \]
\[ \text{U}_A = 17.20 \text{ m/s} \]

The result of fetch calculation from the northeast direction was shown in the figure below. Average effective fetch was calculated from each fetch segments on both side of the wind direction using previous formula (5).

\[ F_{\text{eff}} = 331.68 \text{ km} \]

From the wind stress and average effective fetch gained before, using deep-sea significant wave prediction nomogram, the significant waves height and period could be obtained.

\[ H_S = 5 \text{ m} \]
\[ T_m = 11.2 \text{ s} \]

Finally using the breaking wave height chart, the breaking waves height could be calculated with significant wave height and significant wave period that is previously computed.

\[ \frac{H}{gT^2} = \frac{5}{(9,81 \cdot 11.2^2)} = 0.00406 \]

\[ H_b/H = 1.1 \]
\[ H_b = 1.1 \cdot H = 1.1 \cdot 5 = 5.5 \text{ m} \]

**CONCLUSION**

Based on the calculation of breaking waves height at the shore of Panceng Sub-District – Gresik District, the height of breaking waves is 5.5 m.

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