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Extreme Waves at Filyos, Southern Black Sea

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The Ministry of Transport, General Directorate of Railways, Ports and Airports Construction which is responsible for the design and construction of ports and harbors in Turkey, carried out a wave measurement project for a new planned port in Filyos, Western Black Sea region of Turkey.

The wave measurement project at Filyos lasted for a period of two years. A self-recording pressure type instrument was used to conduct the wave measurements. Directional information of both waves and current was determined according to an electromagnetic system. The instrument was installed at a depth of 12.5m. Wave data were sampled every two hours with a sample length of 20 minutes and a sampling interval of 0.5 sec (i.e. a sampling frequency of 2 Hz). Before any further wave data analysis, the recorded subsurface pressure data was converted into the corresponding surface profile data. Then individual waves were obtained by zero-up crossing method. The characteristic waves like maximum, H_{max}, significant, H_s, one-tenth, $H_{1/10}$, mean wave height H_{mean} and the corresponding wave periods were calculated by using individual waves of each record.

The analysis results show that the maximum significant wave height during the measurement period is 5.0 m. The maximum wave height is 7.5m in this record which makes the ratio of H_{max}/H_s =1.5. The relation between the H_{max} and H_s was investigated through a linear regression and the ratios for chosen 14 storms among the whole record were found to change between 1.38 and 1.88. It is stated that the ratio of H_{max} / H_s is between 1.6 and 2 in the deep water but it decreases to 1.3 through to shallower zones (Goda, 2000). Since the measurement depth in Filyos is 12.5 m which is an intermediate depth, the result can be expected. However; it was noticed during the analysis that there are records in which H_{max} /H_s ratio is higher than 2.0. These higher waves in a record are called as extreme waves using the abnormality index (AI) of Kharif et al. (2009). AI for extreme waves is defined as:

$$\mathrm{AI} = \mathrm{H_{extreme}}/\mathrm{H}_s \quad > 2 \tag{1}$$

209 waves satisfying the condition given in Eq.1 were recorded in Filyos. There are two waves that AI is higher than 4, but it seems that they are spikes. In the rest of the waves, AI is between 2.44 and 2. Thirty records, in which H_s is higher than 1.0 m, have extreme waves with AI value changing between 2.34 and 2. The highest wave is 6.68 m with Hs=3.32 m making AI=2.01. In the record where the AI=2.34, H_{max} is 2.46 m while H_s is 1.05 m.

Detailed statistical and spectral analyses are done for the records having extreme waves. Probability distribution of individual wave heights, joint distribution of the wave height and the period, the relation among the characteristic wave heights and periods and also the wave spectra are computed. Deviation of the waves from the Rayleigh distribution and the nonlinearity by using the parameters like skewness and kurtosis are investigated. For the frequency spectrum analysis, JONSWAP spectrum is fitted on the observed frequency spectra. For the directional spectrum analysis, EMEP (Extended Maximum Entropy Principle Method by Hashimoto (1997)) is used to get the observed directional spectra and directional spreading parameter (Smax value) is calculated. Grouping property is also checked and it is generally observed that the extreme waves which AI is less than 2.3 come in a group.

References

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