18 Deck Flooding Calculation with Short-Term Statistics

Consider a fixed platform subject to storm waves. The waves we consider are those of Sea State 5, for which the modal period is about 9.7 seconds and the significant wave height is about 3.3 meters. Assume that the waves are not affected by the presence of the structure; this is valid for fixed structures which have very small waterplane area. Use the Bretschneider spectrum in what follows.

1. How high must the deck be to suffer a submergence only once every ten minutes? Once per hour? Once per day?

   I get wave elevations of [2.4 2.8 and 3.5] meters. The formulas are:

$$\begin{aligned} M_i &= \int_0^\infty \omega^i S(\omega) d\omega \\ \eta(T) &= \sqrt{-2M_0 \log\left(\frac{2\pi}{T w_{modal}}\right)} \end{aligned}$$

2. What is the average lowest value of the 1/100'th highest waves? Of the 1000'th highest waves? Of the 1/10000'th highest waves?

   I get [2.5, 3.0, 3.5] meters; note these are elevations also. The formulas are:

$$\begin{aligned} \epsilon &= \sqrt{1 - \frac{M_2^2}{M_0 M_4}} \\ z &= \sqrt{1-\epsilon^2} \\ \eta(N) &= \sqrt{2M_o \log\left(\frac{2zN}{1+z}\right)} \end{aligned}$$

3. Comment on how these two ways of expressing statistics are consistent or not.

   These two measures are consistent in two respects. First, the time scales are similar - i.e., there are about 8900 such waves in one day. Second, the average lowest value among the 1/N'th highest is intuitively very close to the highest wave seen in N observations. Note that this average lowest value among the 1/N'th highest waves, the 1/N'th maximum, is in contrast with the average 1/N'th highest value, which is quite a bit larger since it includes waves of arbitrarily large amplitude.

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