Some Evidences of the Existence of Socalled Freak Waves

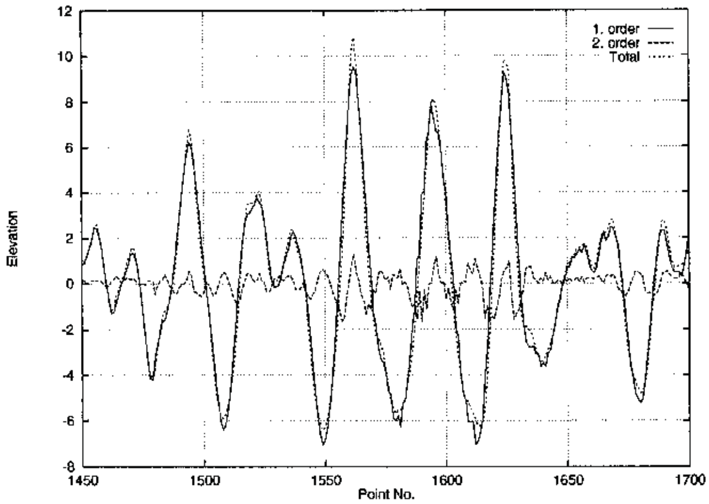
Sverre Haver, Statoil, Exploration and Production Norway,
N-4035 Stavanger
Norway

Abstract for Rogue Waves 2000 workshop, Brest, 29-30 November

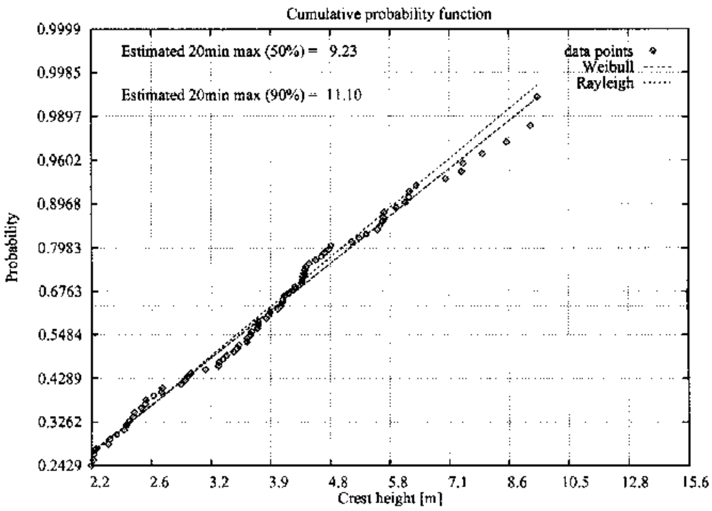
The presentation is introduced by including a discussion for why this author consider it important to assess the possible existence of freak waves. For this purpose, one will briefly consider the risk of wave induced structural collapse relative to other sources that could cause a catastrophic failure of a structure. It will be indicated that in order to yield a sufficiently small contribution to the overall risk of structural collapse, the structure should withstand extreme waves corresponding to an annual probability of exceedance of say 10^{-5}- 10^{-4} without collapsing. If freak waves exist as a special phenomenon, it is expected that they could impact wave events with this small annual probability of occurrence.

The introductory part of the presentation will be closed by discussing a possible definition of a freak wave. At present there is no general concensus regarding such a definition. In the presentation it will be indicated that a second order model seems to be rather accurate regarding crest heights in stormy sea states. Assuming that a measured time series is a realization of a perfect second order process, one may identify the second order component process through an iterative procedure, see Fig. 1(a). Removing this component, the remaining time series should, if our hypothesis is correct, represent a realization of a Gaussian process, i.e. the crest heights should follow a Rayleigh model. This is indicated to be the case in Fig. 1(b). The Rayleigh model seems to yield a good fit to the observed crest heights after removing the second order component. However, for the case shown in Fig. 1(b), it seems as if the Rayleigh-model slightly underpredicts the highest crest heights, indicating that the real processes may be slightly effected by higher order components. Considering freak events as phenomena beyond our present modelling abilities, this author will suggest that freak wave events (unexpected large crest height/wave height, unexpected severe combination of wave height and wave steepness, or unexpected group pattern) should be defined as wave events which do not belong to the population defined by the second order model. In this connection one is not thinking of the possible slight deviations mentioned above when discussing Fig. 1.

The major part of the presentation will be spent on reviewing reported episodes involving very extreme waves. In most cases, these waves have not been meassured so a consideration of whether or not they belong to a separate freak wave population will be rather speculative. However, we will include these, believing that they in sum add up to an experience suggesting the existence of unexpected wave phenomena. Whether these extreme wave events should be considered as rare realizations of a typical extreme wave population or, rather, typical realizations of a rare (freak) wave population, remains to be answered. The presentation will be closed by presenting some few events from the North Sea with crest heights well beyond what should be expected in view of the weather conditions. These events have either been measured directly, or indirectly through damage reports on fixed platforms. One such event is shown in Fig. 2. The figure shows a 20-min. time history recorded by a down looking laser in a storm with a significant wave height of about 12m. The laser is installed on a rather transparent jacket platform and the wave process should not be significantly altered by diffraction from the platform.



(a) Illustration of identified component processes



(b) Distribution of global maxima "first" order process

Fig. 1 Separation of measured time history in component processes

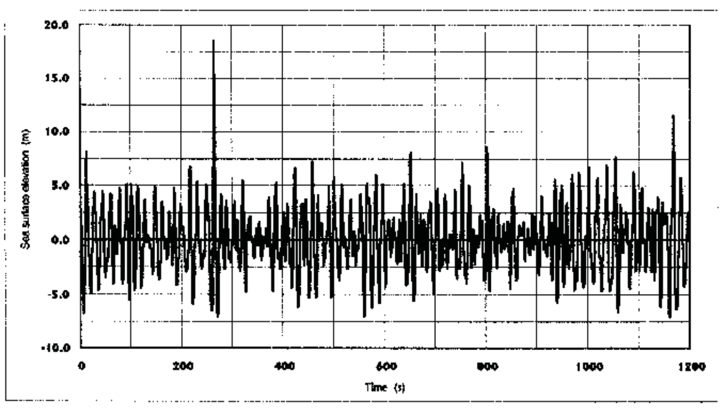


Fig. 2 20-min wave recording from the Draupner Jacket