Contribution to the Report of the Seakeeping Committee of ITTC-78

A comment on the JONSWAP-spectral formulation

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It is recommended by the Seakeeping Committee that the ITTC standard spectrum $S(\omega)$ is modified for fetch limited situations to $S_J(\omega)$, where

$$S_J(\omega) = 0.658\, S(\omega).(3.3)^{e^{-\left(\frac{0.206\omega T_1 - 1}{\sqrt{2}\,\sigma}\right)^2}} \qquad (m^2.s)$$

with $\sigma = 0.07$ for $\omega \leq 4.85\ /T_1$
and $\sigma = 0.09$ for $\omega > 4.85\ /T_1$

This is identical to the formulation presented by the Committee "Environmental Conditions" of the 6th. I.S.S.C.-Boston, 1976.

$$E_J(f) = E_{PM}(f).F_1^{-1}\ \gamma^{\exp\left[-\frac{1}{2\sigma^2}\,(1.296\ f\ T_v - 1)^2\right]}$$

where $E_{PM}(f)$ denotes "Pierson-Moskowitz" formulation, (in fact the I.S.S.C. standard spectrum for open ocean conditions), $F_1 = m_o$ (JONSWAP)$/m_o$(P.M.), and $\gamma = E_{Max}$(JONSWAP)/ E_{Max}(P.M.), provided $\gamma = 3.3$ and, consequently, $F_1 = 1.52$, ("mean JONSWAP" spectrum).

Recently we had the opportunity to obtain some energy spectra from waves recorded by a wave-rider buoy at a location called "A-2 buoy", about 12 km outside, halfway Ostend and Zeebruges, with about 12 m low tide water depth and sandbanks in the neighbourhood. Such location near the Belgium coast may certainly be considered as being in a fetch limited situation, and we could suppose that the JONSWAP spectral representation would be suitable. Available information on the waves was rather comprehensive, viz., 0th and 1st moment m_o and m_1, average wave period T_z, significant wave height, etc., what prompted us to calculate the JONSWAP spectra

according to the formula given above, with $T_1 = 2\pi \frac{m_o}{m_1}$, and $H_{1/3}$ $(= \overline{\zeta}_{w1/3}) = 4\sqrt{m_o}$. The peak frequencies of the measured and the theoretical spectrum agree well, but the peak of the JONSWAP spectrum appears to be too high in all cases. Finally, the corresponding ITTC (or I.S.S.C.) standard spectra were calculated for each case, according to

$$S(\omega) = 173 \frac{H_{1/3}^2}{T_1^4 \omega^5} e^{-\frac{691}{T_1^4 \omega^4}},$$

and the overall agreement is much better.

Only 15 spectra were available. For convenience, only 4 measured spectra, with sufficiently different $H_{1/3}$, are reproduced here in Fig.1, but they reflect pretty well the general characteristics of the whole set of spectra.
A comparison of each measured spectrum with the corresponding JONSWAP and ITTC spectrum shows that

- in the rising low-frequency part, the ITTC spectral ordinates match better than JONSWAP the measured spectral ordinates. Except for the higher sea state ($H_{1/3} > 4$ m), this ascendant part seems to have a less sharp rise than the standard spectra ;
- for the lower sea states ($H_{1/3} \leq 2.5$m) the ITTC spectrum peak agrees fairly well with the measured spectrum peak level; the JONSWAP spectrum peak is excessively high. For the severe sea states ($H_{1/3} > 3$ m) the measured peak spectral density appears to lie between that of the ITTC and the JONSWAP representation, and presumably this measured peak level is approaching the JONSWAP peak when wave height increases to high values ;
- the descending part of the measured spectra, up to higher frequencies, looks somewhat better represented by the JONSWAP than by the ITTC formula, this at least for some cases.

On the whole, the ITTC standard spectrum seems to be more appropriate for this coastal area than the JONSWAP-spectrum, at least for the rather moderate wave heights occurring there.

Of course, the validity of a standard spectrum can't be tested for good by means of such a small number of measured spectra. It is, however, surprising to see that, even small, a randomly chosen sample of the spectrum population in a fetch limited area, is strikingly better approached by the ITTC standard spectrum than by the JONSWAP formulation.

We hope to collect much more wave data from this particular coastal area in the near future, in order to check the statements made here. It might be recommended to continue similar investigations in other coastal areas of the North Sea, in order to verify the applicability of the JONSWAP spectrum formulation. Maybe the introduced value of γ ought to be less than 3.3 for some areas.

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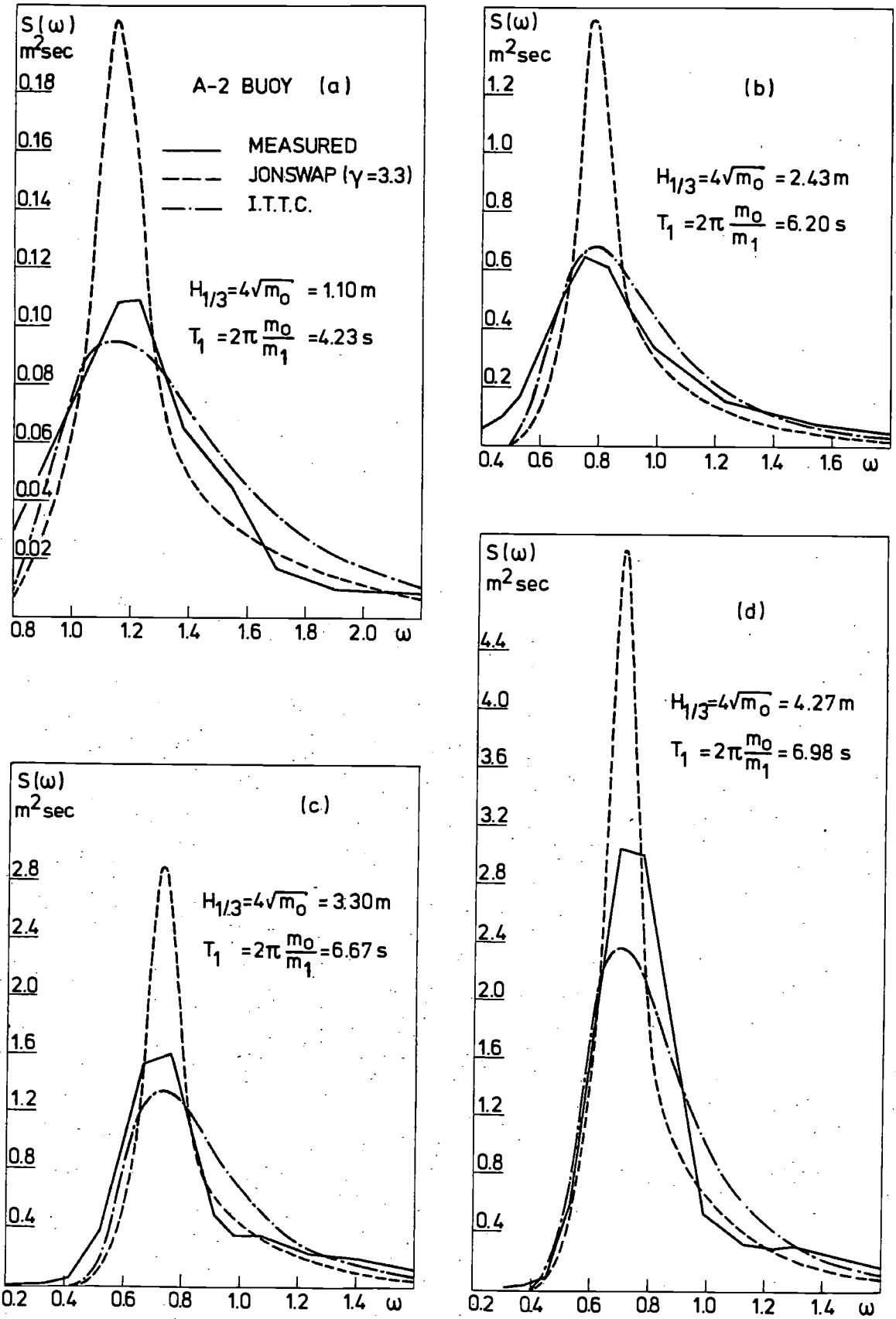

Fig.1 : Spectra North Sea near Belgian coast