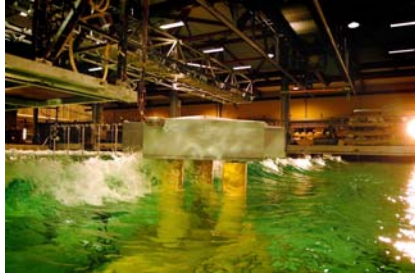


Experimental Studies on Extreme Waves and Interaction with Structures

(a brief overview of some recent and present activities)



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MaxWave Final Meeting, Geneva, Switzerland, 8-10 October, 2003

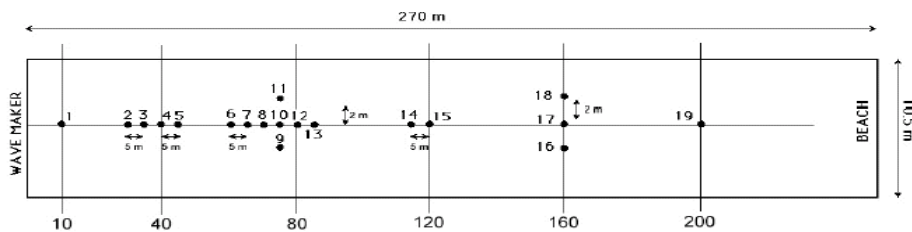
Contents

- New large-tank experiments on extreme wave evolution
- Local non-linearities around a high wave
- Model testing with extreme wave groups – a method
- Model testing of wave impact on platform decks and FPSO

EU-RI "Rogue Waves Experiment" in MARINTEK's 270m wave tank
 (in coop. with Univ. Of Torino, Italy – Prof. Osborne et. al.)

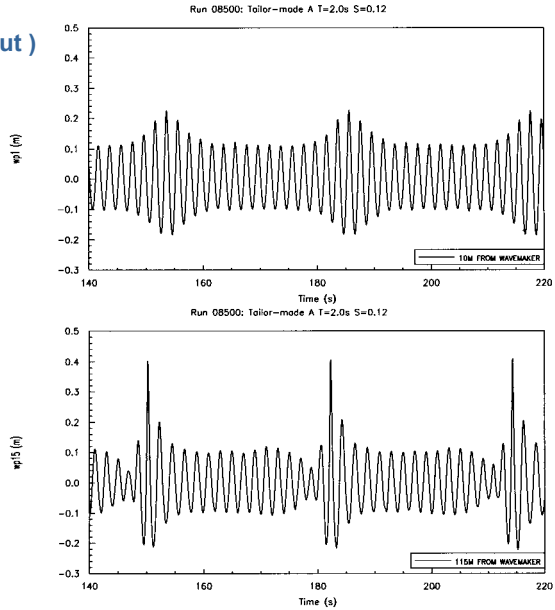


EU-RI experiment: Wave probe locations



Spatial development of a "breeder":

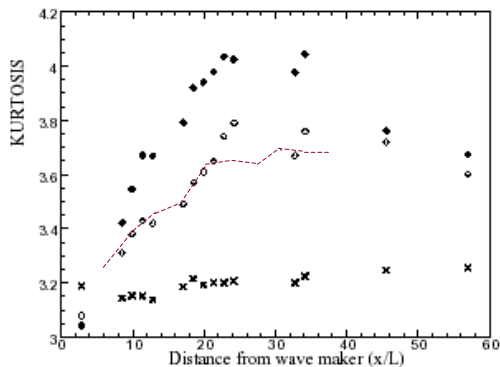
Shown: measured at 10m (\approx input) & at 120m from wavemaker



(to be published)

Random waves: Kurtosis vs. propagated distance;
JONSWAP, 3 spectral bandwidths ($\gamma = 1 - 3 - 6$)

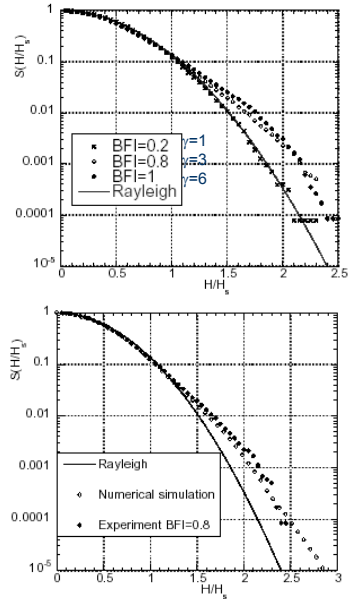
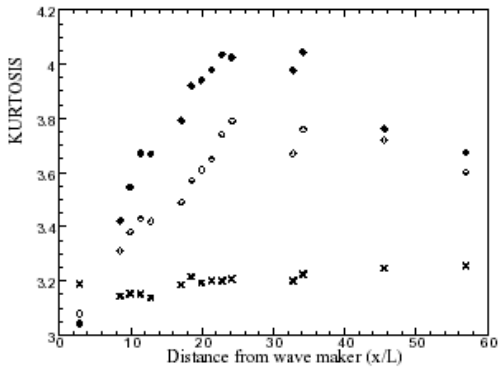
Kurtosis > 3 indicates higher-order effects in wave heights



(more than 6000 wave cycles)

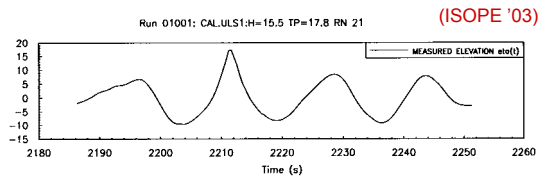
----- : comparison to Stansberg (ISOPE 2000) ($\gamma = 3$; smaller scale; wide Ocean Basin)

Wave height probability distributions

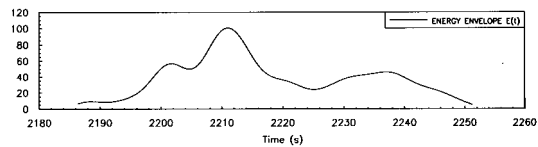


Hilbert transform analysis of irregular wave record (Ocean Basin tests):

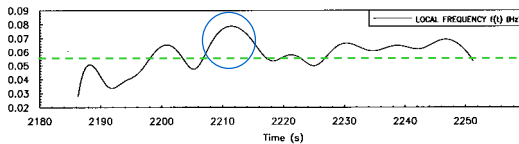
Elevation $\eta(t)$ [m]



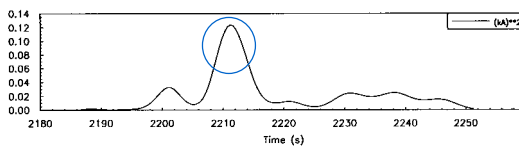
Energy envelope $E(t)$ [m^2] (from "free" wave comp.)



Local frequency $f(t)$ [Hz] = $\partial\phi/\partial t$ (from "free" wave)



Steepness squared $(kA)^2$ (from "free" wave)



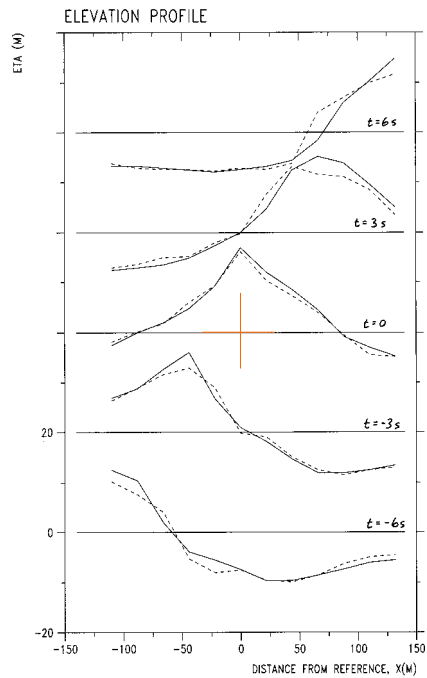
Spatial profile of
high laboratory wave
vs. 2nd order model

Time evolution, 5 instants

$x=0$; $t=0$ defines reference

(full scale values)

———— = measured
- - - - - = model



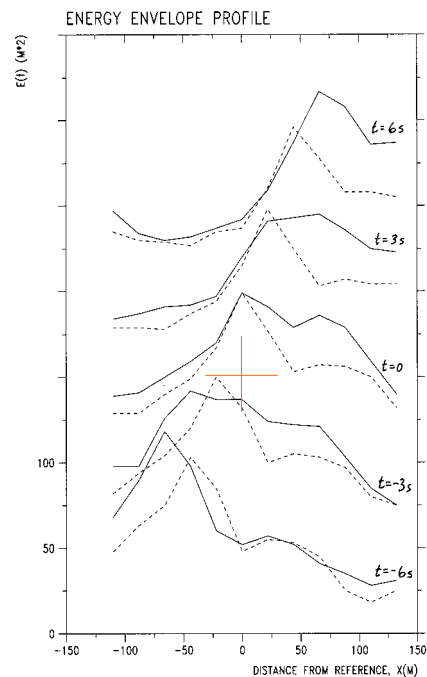
Spatial profile of
high wave energy envelope
("wave group")
vs. linear propagation

Time evolution, 5 instants

$x=0$; $t=0$ defines reference

20% - 30% increased group velocity:
⇒ high crests stay high longer

———— = measured
- - - - - = model

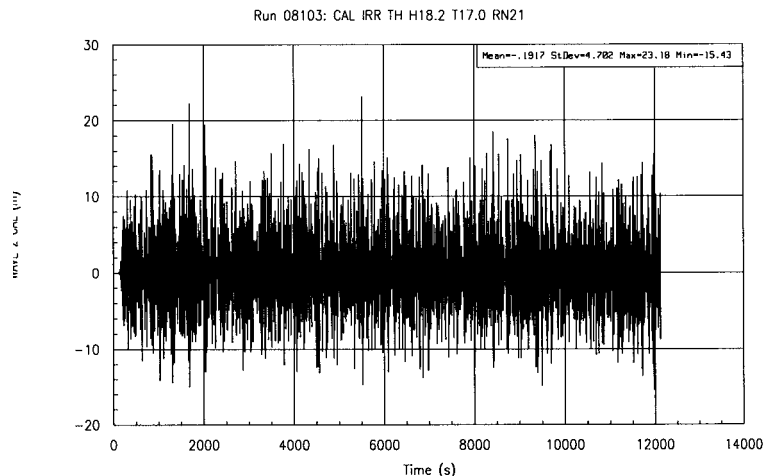


Testing in extreme wave events - in order to study rare, "transient" responses

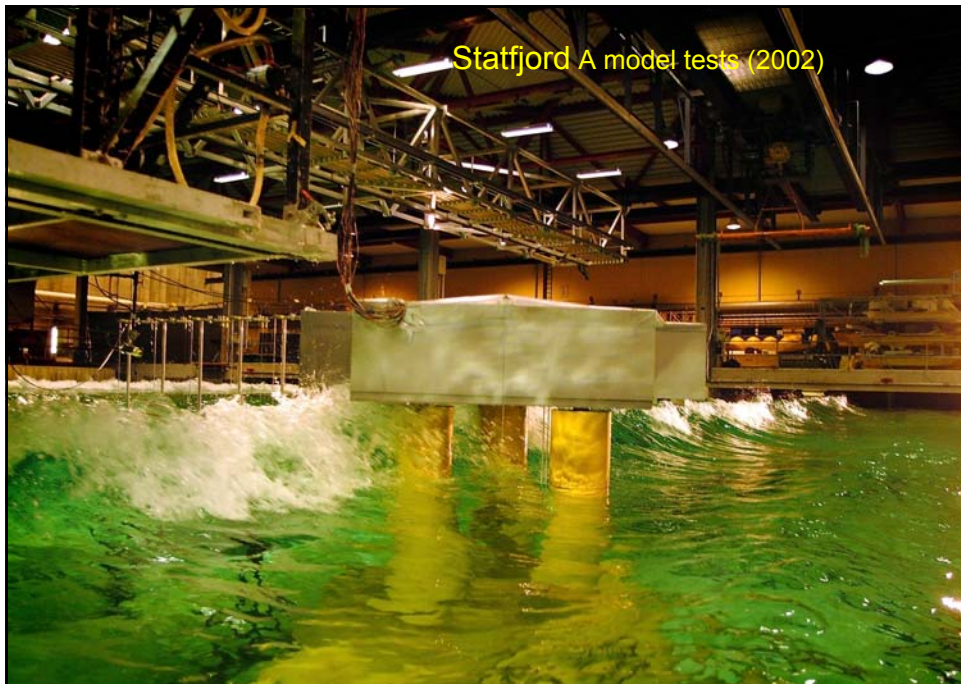
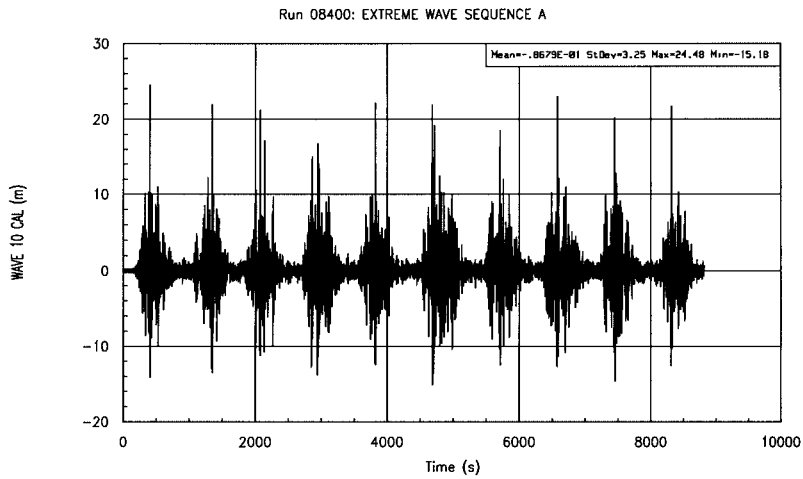
- *Response examples:* Ringing; slamming and other strongly nonlinear phenomena.
- *Irregular waves, simulating e.g. 3 hours storms:*
Some times they "produce" only $\approx 2 - 3$ critical response events. Many realisations may be needed to give reliable statistics.
- *Alternatively:* Test in selected, "transient" wave groups.
Problem: How do we select the wave groups?
Specific, designed waves? Which characteristics?

One option: Pre-calibrate full irreg. records.
Then pick out selected time windows
and put them together.
(Selection criteria?)

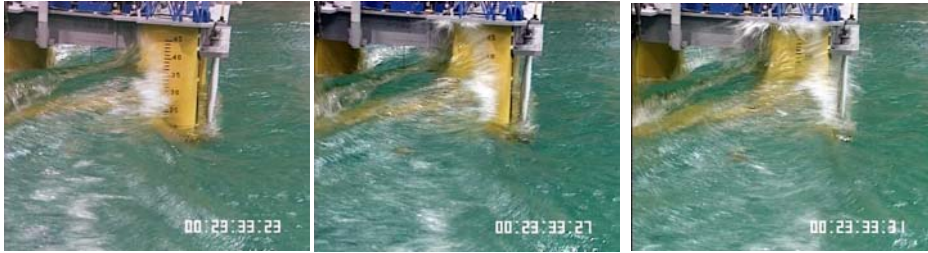
A 3-hour random realisation of a 10-000 yr North Sea storm



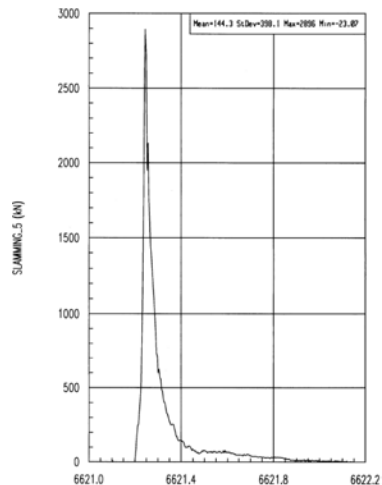
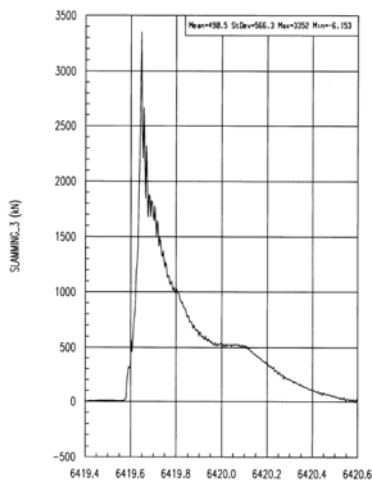
Extreme groups put together, picked out from many realisations



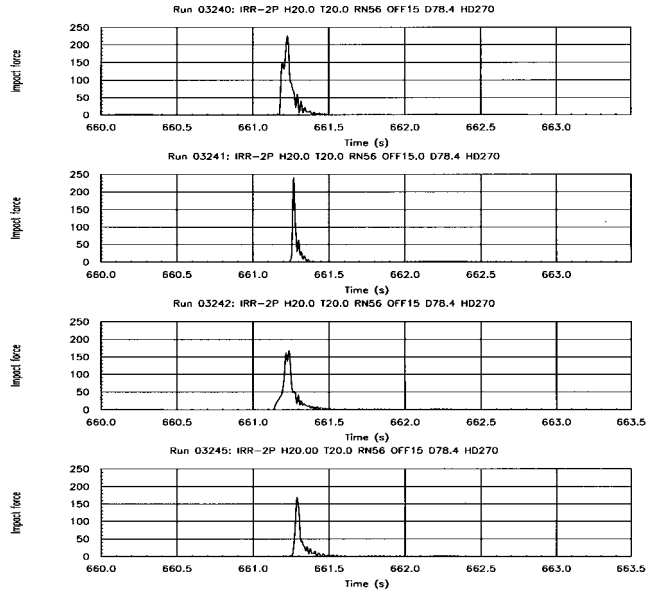
Nonlinear wave impact on moored semisubmersible in 10 000 year Norwegian Sea Storm



Two deck impact load events

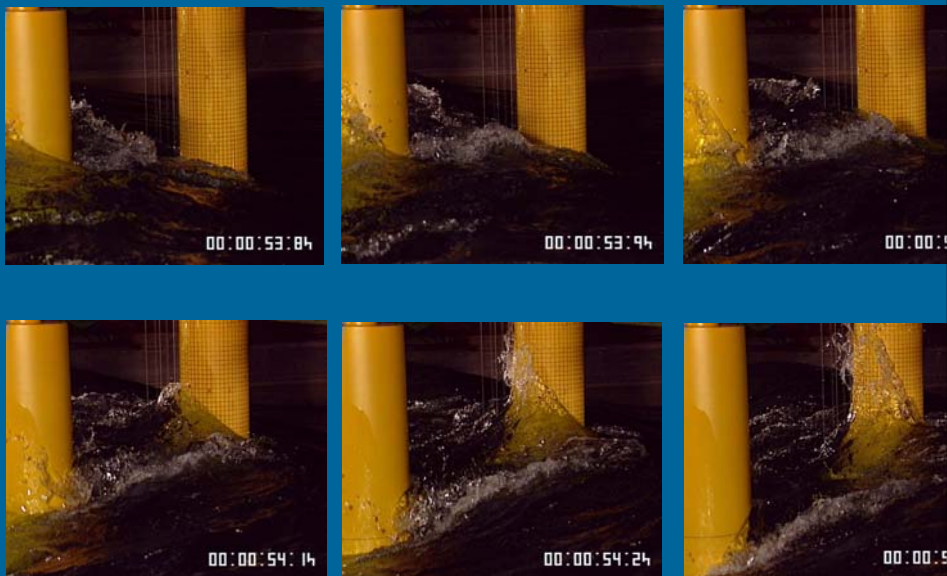


Example from another experiment: Wave-in-deck impact load in irregular wave - Four repetitions



Basic research study on fixed vertical columns (Norsk Hydro/MARINTEK/NTNU)

(used as part input in new MARINTEK Platform JIP (WaveLand II))

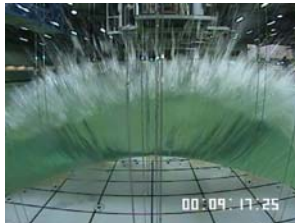


Green sea experiment

From the side – bow



Forward from deckhouse



From above - bow



Two succeeding green sea events in irregular sea:

