# LIP11D DELTA FLUME EXPERIMENTS
## Prediction of wave transformation

Contribution from Luc HAMM[1] - V1.0 - 29 April 1993

## Objectives

This note reports simulations carried out to simulate wave transformation along the flume following the initial beach profile and the wave conditions given in Roelvink(1993). Parametric spectral and wave-by-wave approaches are compared. An estimation of the distribution of the skewness of the bottom orbital velocity along the flume is also given.

## Initial beach geometry

The initial beach profile consists of four parts:

- an initial flat bottom between x=0 and 20 m at z=0.,
- a constant sloping part with a slope of 1 in 20 between x=20 and 52 m (z= 0 to 1.6 m),
- a Dean's profile of the form $z= 4.1 - 0.1(177-x)^{2/3}$ between x= 52 and 169 m (z=1.6 to 3.7m),
- a constant sloping part with a slope of 1 in 30 between x=169 and 203m (z=3.7 to 4.83m).

x = 0. corresponds to the wave-maker and z = 0. to the flume bottom.

## Wave conditions

The three following wave conditions will be used during the experiments.

| test case | $H_{rms}$ (m) energy-based wave height | $T_p$ (s) peak period | h (m) water depth |
|---|---|---|---|
| a | 0.6 | 5.0 | 4.1 |
| b | 1.0 | 5.0 | 4.3 |
| c | 0.3 | 6.0 | 4.1 |

Table 1: Incident wave conditions

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## Simulations in the spectral domain

The parametric spectral approach has been used following Battjes and Stive(1985). Results showing the evolution of the energy-based wave height $H_{rms}$ (more correctly referred as $H_E$) for the three test cases are drawn on figure 1. It should be noted that the gamma coefficient in the formulation as been computed according to the empirical fit given in Battjes and Stive paper. For comparison purposes, the new fit proposed by Nairn(1990) which gives lower values for low steepness waves has also been used in test c.

## Simulations in the time domain

A wave-by-wave approach with the software REPLA has also been used. For that purpose, it has been assumed that the incident root-mean-square wave height $H_{rms}$ defined in the time domain is equal to the incident energy-based wave height $H_E$ defined in table 1. Two types of incident wave distributions have been simulated. In the first one, 15 wave heights have been selected assuming a Rayleigh distribution associated with a single frequency $f_p$ (see table 2). In the second case, a full joint distribution of periods and heights has been used with an assumed mean period ($T_m$) of 4.3s and mean wave height ($H_m$) of 0.53m for the test case a. As no standard theoritical joint distribution is presently available, laboratory records with equivalent wave steepness and relative water depth have been analysed. The resulting non-dimensional probability distribution has been used to define 34 individual waves (see table 3).

The evolution of $H_{rms}$ and $H_{1/3}$ for both distributions are drawn on figure 2 (upper part). There is no significant difference between both results. The result obtained from the parametric spectral approach is also shown. As expected, $H_{rms}$ becomes larger than $H_E$ in the surf zone. A comparison of the fraction of breaking waves along the profile is also given in the lower part of figure 2. Significant differences are observed between the two approaches. The wave-by-wave approach could also give an estimate of the non-breaking and breaking wave height distributions along the profile. The four currentmeter stations at x= 100, 130, 145 and 160m have been chosen to display these distributions in the case of an incident Rayleigh distribution (figure 3) and a joint distribution (figure 4).

## Near-bottom velocity skewness

The parametrized form of the covocoidal theory as been used to estimate the skewness of the horizontal near-bed velocity along the profile. The results of a simple approach using $H_{rms}$ and the peak period are presented in figure 5.

Rayleigh distribution

| | | |
|---|---|---|
| Hrms | 0.6 | |
| Hmax | 1.452 | |
| deltaH | 0.1 | 400 |

| H (m) | p (H) | Nb waves |
|---|---|---|
| 0.05 | 0.028 | 11 |
| 0.15 | 0.078 | 31 |
| 0.25 | 0.117 | 47 |
| 0.35 | 0.138 | 55 |
| 0.45 | 0.142 | 57 |
| 0.55 | 0.132 | 53 |
| 0.65 | 0.112 | 45 |
| 0.75 | 0.087 | 35 |
| 0.85 | 0.063 | 25 |
| 0.95 | 0.043 | 17 |
| 1.05 | 0.027 | 11 |
| 1.15 | 0.016 | 6 |
| 1.25 | 0.009 | 4 |
| 1.35 | 0.005 | 2 |
| 1.45 | 0.002 | 1 |

Table 2

Probability distribution of a joint distribution of periods and heights

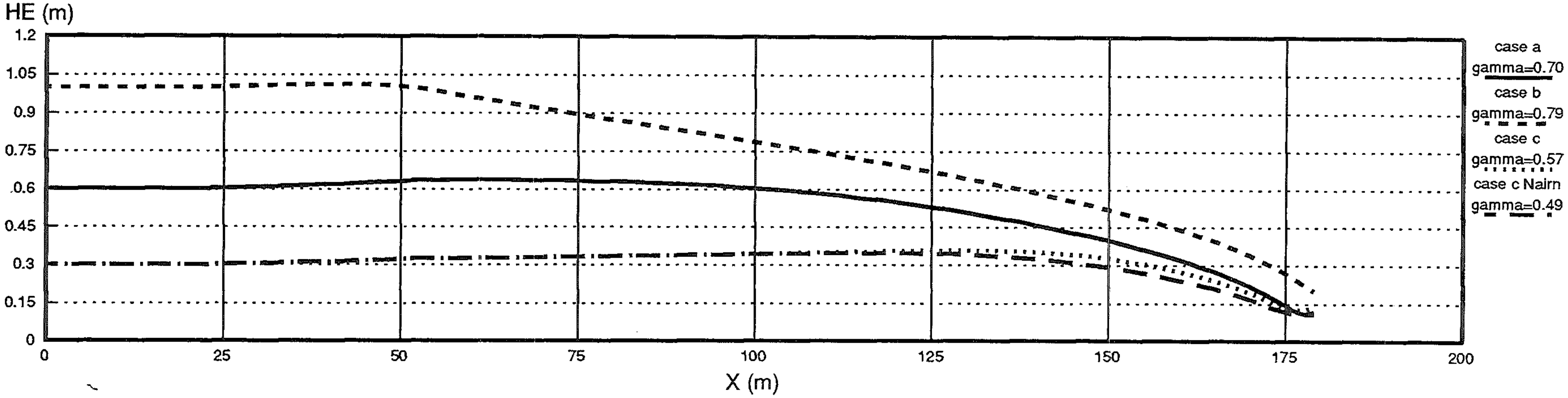
| T/Tm | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 | 1.1 | 1.3 | 1.5 | |
|---|---|---|---|---|---|---|---|---|---|
| H/Hm | | | | | | | | | tot |
| 0.1 | | | 2.0 | | | | | | 2.0 |
| 0.3 | | 1.0 | 2.9 | 1.3 | | | | | 5.2 |
| 0.5 | | | 3.3 | 4.9 | 3.6 | 2.0 | 1.6 | | 15.3 |
| 0.7 | | | | 5.2 | 2.3 | 2.9 | 3.6 | 1.3 | 15.3 |
| 0.9 | | | | 2.0 | 4.9 | 3.9 | 4.9 | | 15.6 |
| 1.1 | | | | 1.0 | 4.6 | 4.6 | 3.3 | 1.3 | 14.7 |
| 1.3 | | | | | 1.6 | 4.9 | 3.6 | | 10.1 |
| 1.5 | | | | | 2.3 | 4.6 | 2.6 | | 9.4 |
| 1.7 | | | | | 2.3 | 5.2 | | | 7.5 |
| 1.9 | | | | | | 2.0 | | | 2.0 |
| 2.1 | | | | | | 1.6 | | | 1.6 |
| 2.3 | | | | | | 1.3 | | | 1.3 |
| tot | 0.0 | 1.0 | 8.1 | 14.3 | 21.5 | 32.9 | 19.5 | 2.6 | 100.0 |

Table 3

## LIP11D Experiments

**Wave transformation**

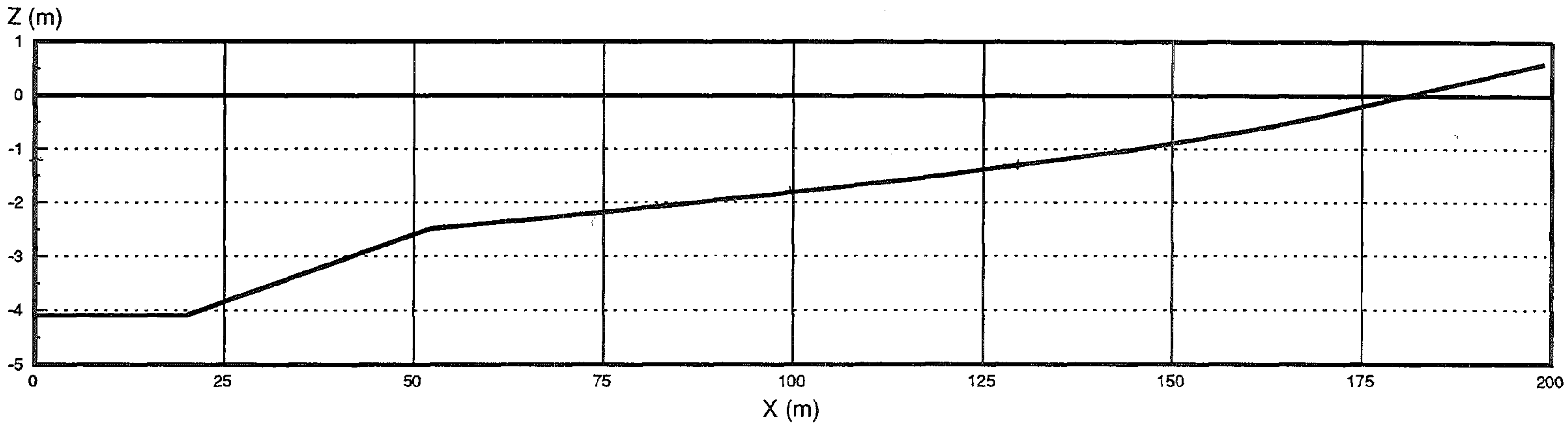
**parametric spectral approach**

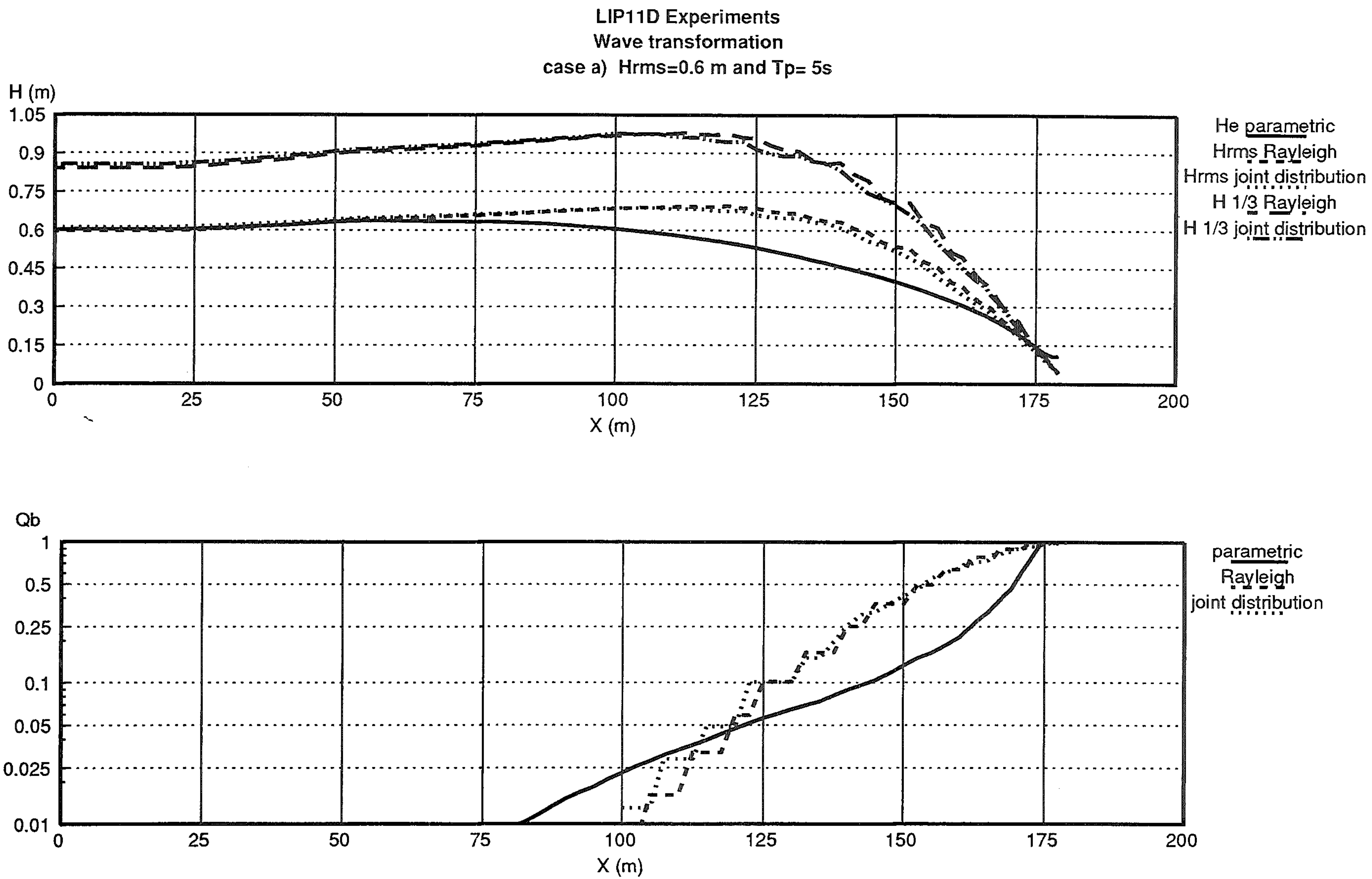



## LIP11D Experiments

**Wave transformation**

**initial beach profile**

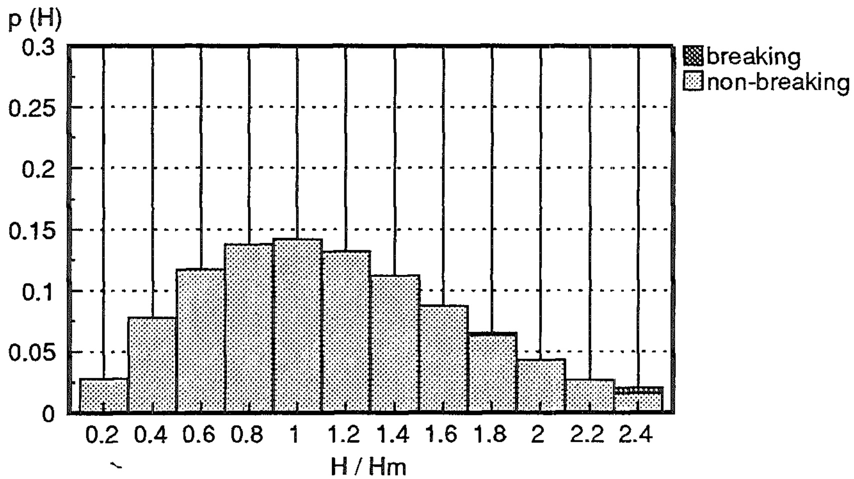




LIP11D Experiments
Wave transformation
case a) Hrms=0.6 m and Tp= 5s
H (m)
1.05
0.9
0.75
0.6
0.45
0.3
0.15
0
0
25
50
75
100
125
150
175
200
X (m)
He parametric
Hrms Rayleigh
Hrms joint distribution
H 1/3 Rayleigh
H 1/3 joint distribution
Qb
1
0.5
0.25
0.1
0.05
0.025
0.01
0
25
50
75
100
125
150
175
200
X (m)
parametric
Rayleigh
joint distribution

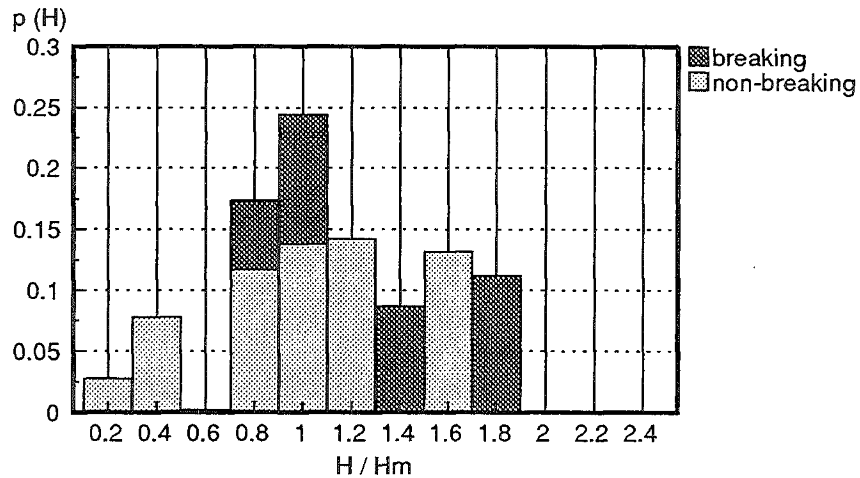
**LIP11D Experiments**

**Wave height distribution at X= 100m**
**case a) Hrms=0.6 m and Tp= 5s**



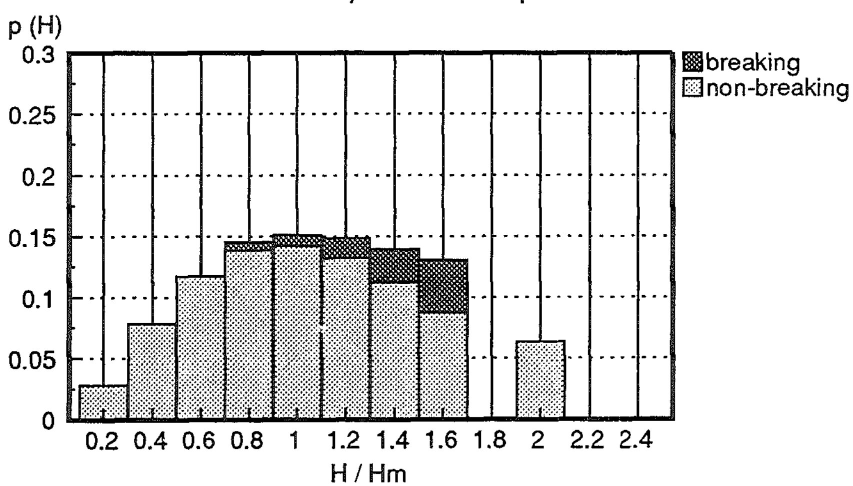

**LIP11D Experiments**

**Wave height distribution at X= 145m**
**case a) Hrms=0.6 m and Tp= 5s**



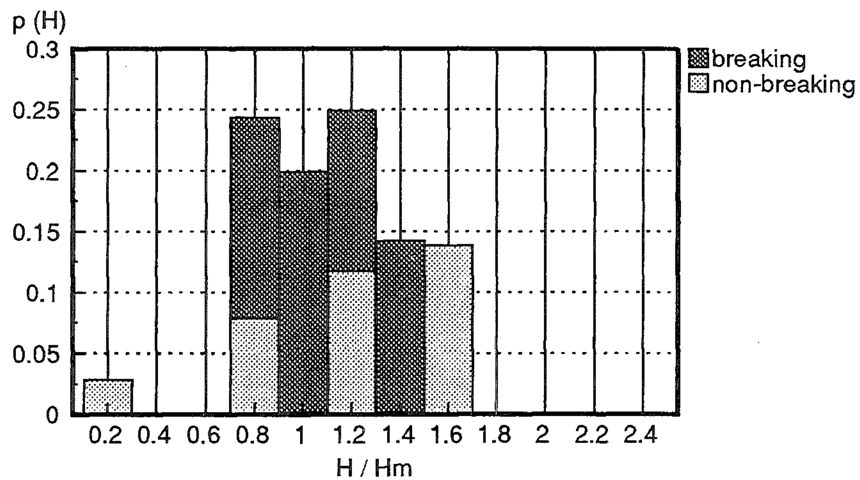

**LIP11D Experiments**

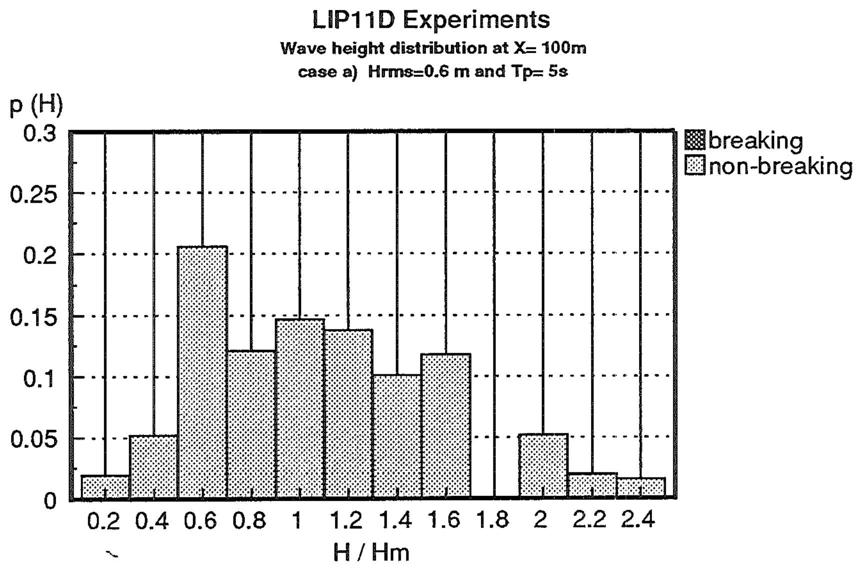
**Wave height distribution at X= 130m**
**case a) Hrms=0.6 m and Tp= 5s**



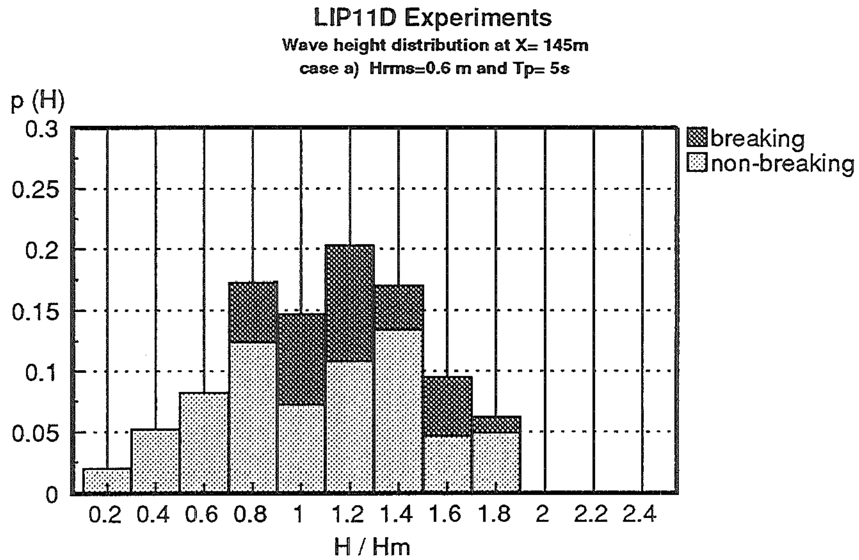

**LIP11D Experiments**

**Wave height distribution at X= 160m**
**case a) Hrms=0.6 m and Tp= 5s**

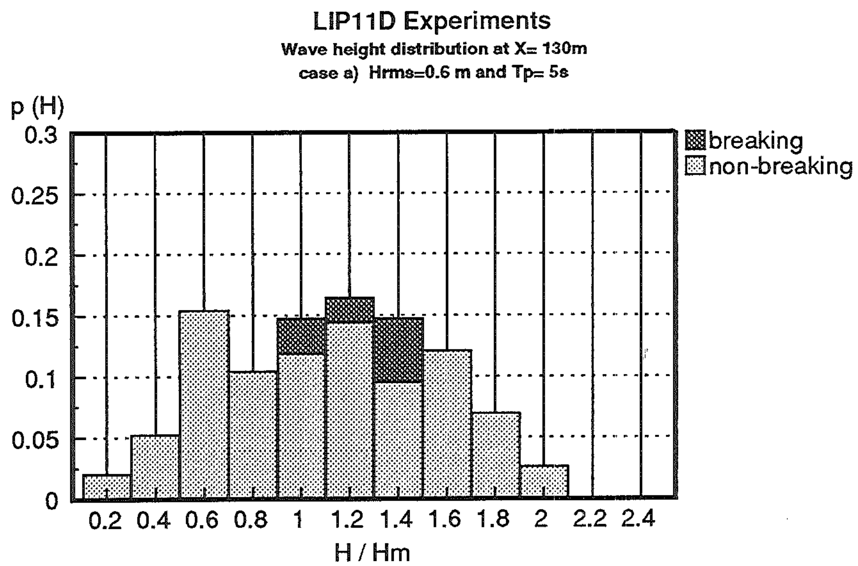




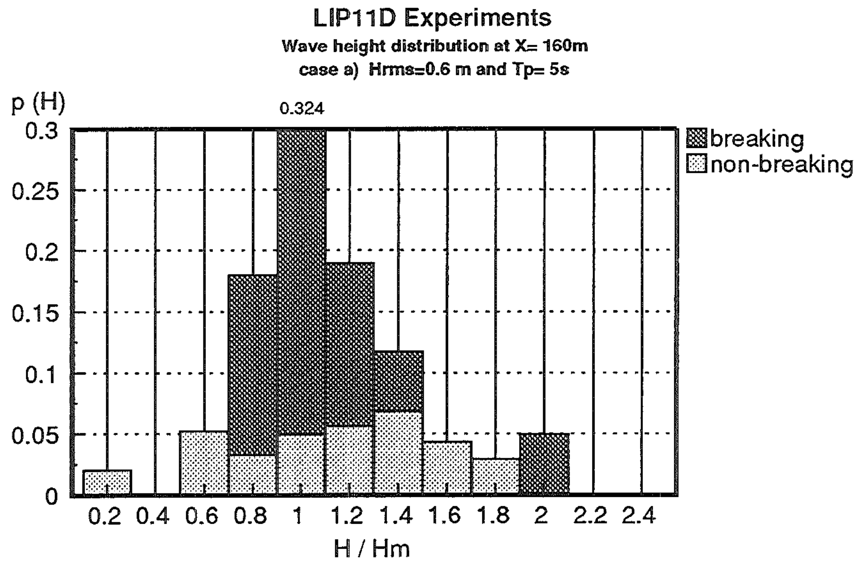
LIP11D Experiments
Wave height distribution at X= 100m
case a) Hrms=0.6 m and Tp= 5s
p (H)
breaking
non-breaking
H / Hm

LIP11D Experiments
Wave height distribution at X= 145m
case a) Hrms=0.6 m and Tp= 5s
p (H)
breaking
non-breaking
H / Hm

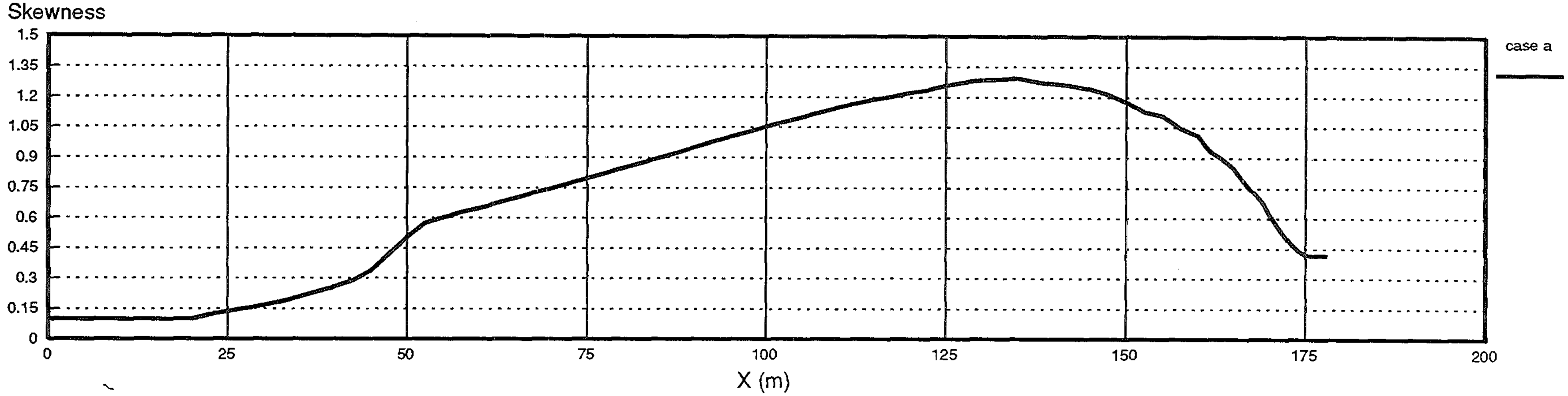
LIP11D Experiments
Wave height distribution at X= 130m
case a) Hrms=0.6 m and Tp= 5s
p (H)
breaking
non-breaking
H / Hm

LIP11D Experiments
Wave height distribution at X= 160m
case a) Hrms=0.6 m and Tp= 5s
p (H)
0.324
breaking
non-breaking
H / Hm

## LIP11D Experiments

**Wave transformation**
**Skewness of near-bed velocity**




## LIP11D Experiments

**Wave transformation**
**initial beach profile**