SECOND INTERNATIONAL CONFERENCE ON
PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS
UNIVERSITY OF ICELAND
DEPARTMENT OF ENGINEERING AND SCIENCE

A NORWEGIAN WAVE CLIMATE STUDY

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INTRODUCTION

In order to obtain criteria for operation and design of marine structures dependable wave data are needed. It is well known that the lack of such data is typical for most waters in the world including the Norwegian.

A wave research program at the Division of Port and Ocean Engineering at The Norwegian Institute of Technology includes wave measurements at 3 sites on the coast at depths from 80 to 140 meters. Parts of this program has been active for 4 years such that some data are available for design purposes.

Also visual data observed from lighthouses have been analyzed. Grants for this research are awarded from The Royal Norwegian Council for Technical and Scientific Research and The Continental Shelf Division of the same foundation.

It appears though that there is a deficit of wave data for design and operation purposes. The Continental Shelf Division therefore set up a committee to consider these problems. The committee has proposed a program consisting of a wave measurement and a hindcasting project that are now started under the support of the Continental Shelf Division.

WAVE RECORDING PROJECT

General

This project includes 10 stations on the continental shelf where waves shall be measured to provide information on wave height, -period, one dimensional wave spectra etc., Fig. 1. Measurements are automatically started every three hours, simultaneously with routine measurements and observations of meteorological variables. The wave record length is 20 min and the sampling interval is 0.5 sec.

It remains to be proved wether 10 recording stations are optimum to secure representative data for the entire Norwegian Continental Shelf. Controls of representativity are planned through correlation and comparison of wave parameters calculated from simultaneous records obtained at neighbouring stations.

Instrumentation

General - It is proposed to make use of the socalled Datawell Waverider at all of the 10 sites. This wave recorder consists of a spherical stainless steel hull of diameter 0.7 meters. In the hull is mounted an accelerometer, and two integrators by which vertical accelerations are integrated twice to provide the wave elevation. Data are telemetered by radio to a lighthouse or a platform where a receiver is installed, and data are recorded in digital form on cassette tape. The cassettes are sent to a computer centre for data control and analysis. The whole system is depicted on Fig. 2.

Buoy and mooring - According to experience gained by the Norwegian Institute of Technology the life of the Waverider batteries is up to 16 months. Maintenance intervals for wave recorder and mooring system have been from 6 to 16 months.

During the last 4 years 2 to 3 Waveriders have been in operation off the Norwegian coast at depths of 80 to 140 meters. Within these years there have been only one case of mooring failure. The mooring system is shown on Fig. 3 in the case of a depth of 100 meters.

Data recording - The radio receiver is automatically started every 3 hours and records data for 20 minutes. On a strip chart the time-history of the waves is displayed. Simultaneously the analogue signal in the form of a DC voltage is fed into a system that digtizes and stores data on a magnetic tape of the cassette type. The tape-recorder is an unmodified commercial audio type instrument.

The sampling interval is 0.5 sec such that the shortest wave to be analyzed has a period of one sec.

Errative data may occur due to failures in the data recording unit. To select such errors each numerical value is recorded twice, and data control is undertaken during the convertion to computer compatible tape. Using this recording routine one cassette of tape is filled with data after 4 to 5 days.

Data convertion - The data are converted to computer compatible tape by a small computer that can read cassette tapes. A data control routine skips those of the numerical values that are most likely to be erratic. Data are then stored on files and printed out on computer compatible paper or magnetic tape.

Routine data analysis - The first step of the routine data analysis is a data control that seeks for errors introduced by the wave recorder itself or by telemetry problems such as radio interference. A message on data quality is printed out for every wave record.

The following parameters are printed out, Fig. 4.

Each recording station will lead to 8 pages as Fig. 5 per day, or close to 2400 pager per year. Therefore accumulated data will be analyzed to provide monthly and yearly as well as long term statistics to provide more compressed information.

A data retrieval system has also been developed to secure that results of analyses as well as original data are easily accessible.

HINDCASTING PROJECT

To satisfy the need for design criteria it is necessary to estimate the seize and probability of occurrence of the most severe environmental conditions that can be met during the life of the structures to be operated on the continental shelf.

As such structures in a limited number of years will be in use on most of the Norwegian continental shelf, it is quite clear that wave measurements from now on can not meet the requirements for design criteria because data from many years are needed. A hindcasting project will therefore be started.

It is believed that hindcasting of the most severe storm that occurred every month 30 years back in time will provide sufficient information. Then it will be possible to estimate distributions of the extremes within each month as well as the marginal distribution of extremes.

Other interesting information from this project is e.g. the duration of extreme storms.

CONCLUSION

The proposed Norwegian Wave Climate Study is within a few years, believed to meet the most important requirements to wave data for design and operation of marine structures on the Norwegian Continental Shelf. Many of the needs for wave data within basic research will also be satisfied.

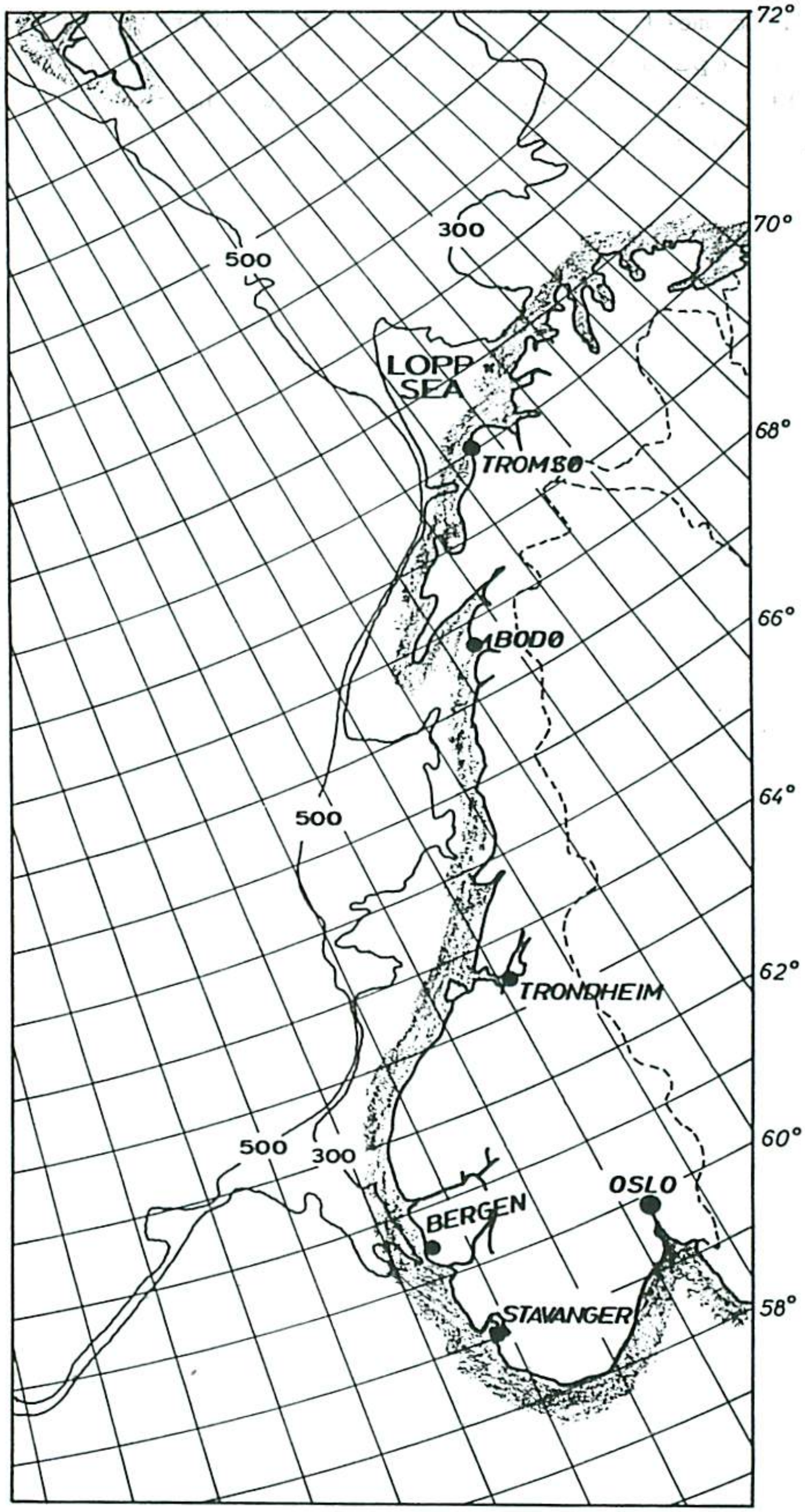

FIG. 1. LOCATION MAP

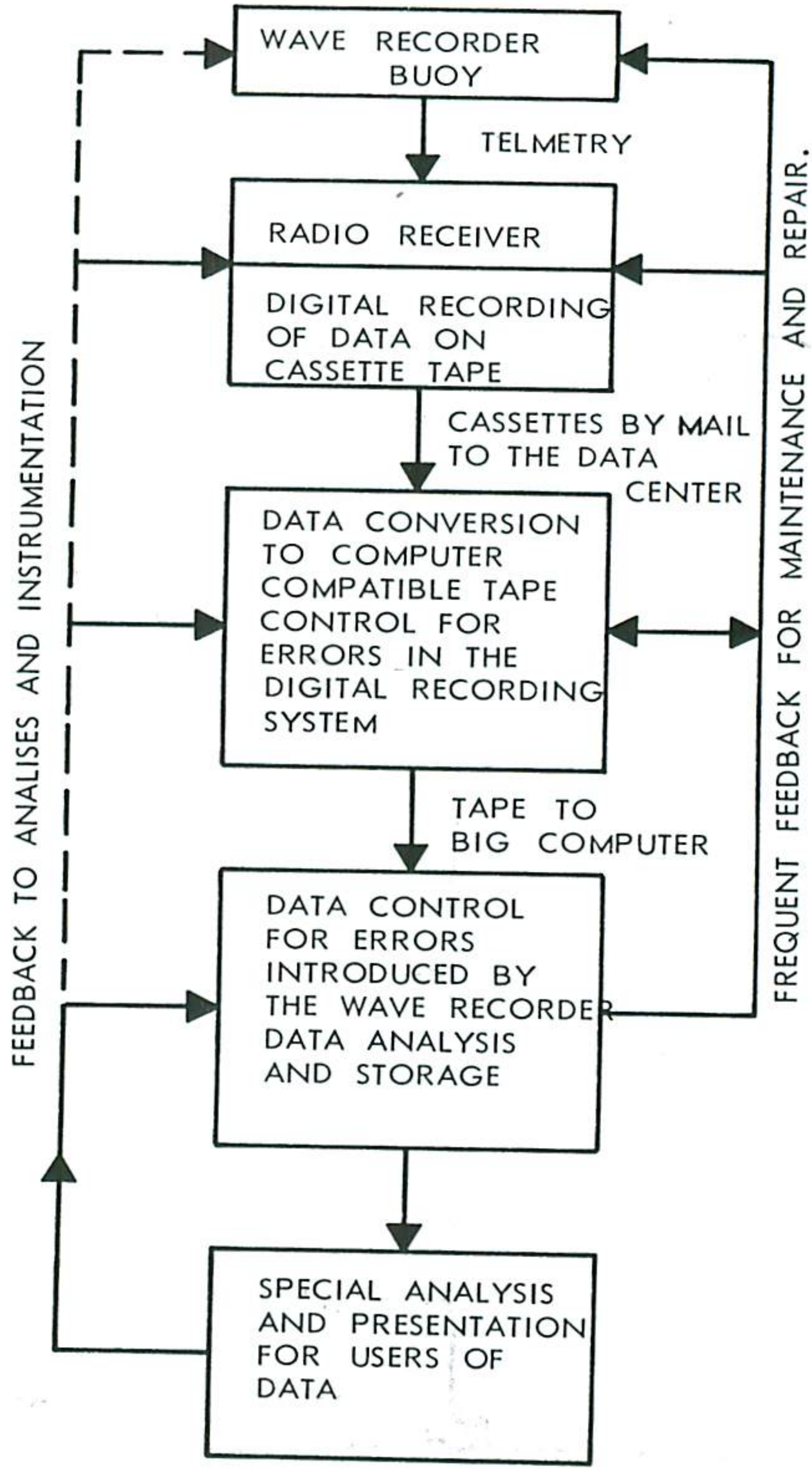

FIG.2. INSTRUMENTATION AND ANALYSIS SYSTEM.

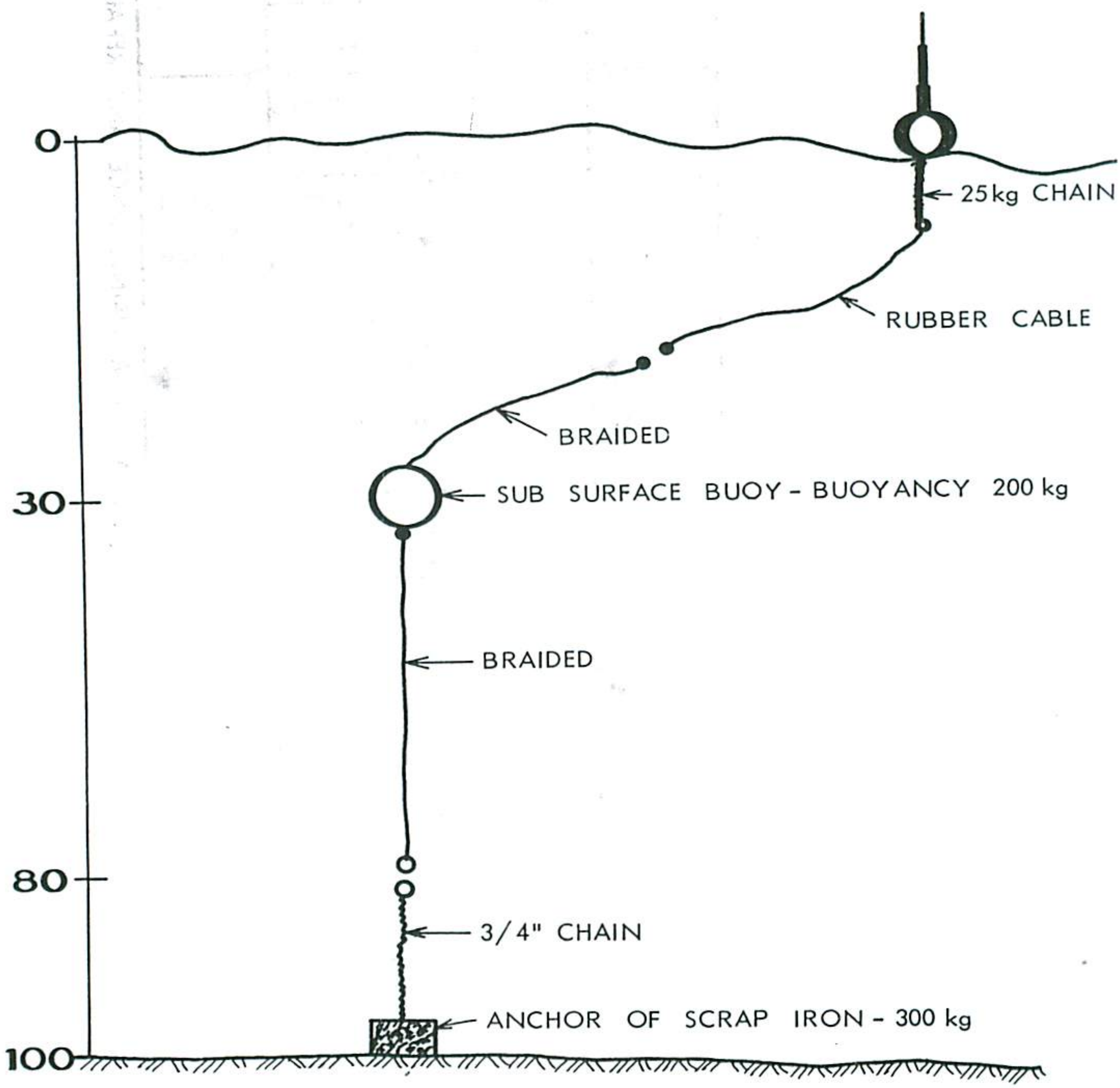

FIG. 3. WAVERIDER MOORING

H	-	INDIVIDUAL WAVE HEIGHT
HMEAN	-	AVERAGE OF H
H13	-	SIGNFICANT WAVE HEIGHT - AVERAGE OF THE HIGHEST ONE THIRD OF THE WAVES IN A RECORD
HMAX	-	HIGHEST WAVE IN A RECORD
T	-	PERIOD OF AN INDIVIDUAL WAVE
TZ	-	ZERO CROSSING PERIOD
T13	-	SIGNIFICANT WAVE PERIOD - AVERAGE OF THE LONGEST ONE THIRD OF THE PERIODS IN A RECORD
THMAX	-	WAVE PERIOD CORRESPONDING TO THE SPECTRAL PEAK
M0,M1,M2	-	MOMENTS OF THE SPECTRUM
S1	-	STEEPNESS OF AN INDIVIDUAL WAVE
SMEAN	-	AVERAGE OF S1
S1MAX	-	MAXIMUM VALUE OF S1 IN A RECORD
S1HMAX	-	STEEPNESS OF HMAX
S2	-	STEEPNESS CALCULATED FROM H13 AND TZ
NZ	-	TOTAL NUMBER OF CRESTS IN A RECORD
NC	-	NUMBER OF CRESTS OF WAVE CROSSING THE ZERO LINE
EPS	-	PARAMETER FOR SPECTRUM WIDTH
A	-	NUMBER OF ORDINATES AFTER CORRECTION
B	-	DURATION OF CORRECTED RECORD IN MIN. AND SEC.
C	-	NUMBER OF ERRATIC ORDINATES
D	-	NUMBER OF SUSPECT ORDINATES
P	-	NUMBER OF DEGREES OF FREEDOM OF SPECTRUM
SIG2T	-	VARIANCE OF T
SIG2S1	-	VARIANCE OF S1
MOM2SO	-	ESTIMATE OF TZ
MO4SOR	-	ESTIMATE OF H13
HS1MAX	-	HEIGHT OF WAVE CORRESPONDING TO S1MAX
TS1MAX	-	PERTON OF WAVE CORRESPONDING TO S1MAX

Fig.4 PARAMETER DEFINITIONS

STATION NO.: 1

TIME: 12: 0: 0 DATE: 16/3 YEAR: 72

SAMPLE 1

HMEAN	= 4.47	T13	= 13.73	TZ	= 9.43	D	= 0
HS1MAX	= 1.25	S1MAX	= 0.15	TS1MAX	= 2.27	P	= 0
H13	= 7.38	S1MEAN	= 0.04	NZ	= 122	A	= 2340
HMAX	= 12.17	S2	= 0.05	THMAX	= 13.01	C	= 0
SIG2T	= 0.40	S1HMAX	= 0.05	SIG2S1	= 0.658	NC	= 248
M04SQR	= 2.82	TMAX	= 15.06	MOM2SQ	= 10.14	TL	= 21.29
M0	= 7.94	M1	= 4.42	M2	= 3.05	TU	= 6.24
EPS	= 0.76	B	= 19:30				

NO SUSPECT OBSERVATIONS

NO ERRATIC OBSERVATIONS

NO OBSERVATIONS REJECTED

NO BEAT

Fig.5 COMPUTER OUTPRINT OF RESULTS FROM ONE WAVE RECORD