# CONFERENCE REPORT

## Fourth International Conference on Port and Ocean Engineering under Arctic Conditions

*St. John's, Newfoundland, Canada, September* 26 30, 1977

Approximately 300 delegates from some twenty countries attended the conference held at the Memorial University in St. John's Newfoundland. Eighty-four technical papers were presented in three concurrent sessions (A, B and C). Six invited papers and three summary papers were given in plenary sessions. The separate subject areas were divided as follows: A Platform design; Port and ocean engineering; Ocean engineering and marine transportation; Marine transportation; B — Sea ice; Ice mechanics; Ice Forces on structures; Icebergs; C — Offshore development and the environment; Physical oceanography and the environment; Physical oceanography; Remote sensing, data collection and processing.

The proceedings of this conference, two large volumes (of over 500 pages each) were produced by the Ocean Engineering Information Centre of the Memorial University of Newfoundland.

*Invited Papers*

The first invited paper, presented by K. R. Croasdale provided an excellent introduction to the topics of session A, as well as some topics covered in session B. The scene is set and the various areas of interest around the Canadian coastline are described according to ice conditions which prevail. The three representative areas are taken to be: (1) the Beaufort sea which is suitable for drilling from artificial islands and floating vessels in summer; (2) the Arctic Islands where the ice cover is virtually permanent and drilling off the ice or subsea development is possible; (3) the East Coast where the water is relatively deep and ice free conventional floating rigs or drilling ships may be used here, although icebergs are a problem. Ice forces on structures are also discussed and the differences between ice failure in flexure and ice failure under crushing are described, these considerations have given rise to the design of the cone monotowers described in detail later in the proceedings.

Hibler then presented the results of a finite difference code to model the deformation and thickness of the ice in the Arctic Basin using a time step of one day and a resolution of 125 km the viscous-plastic constitutive law for the ice gave 'characteristically similar' behaviour to that observed by Landsat.

Schwarz discussed some new developments in the physical modelling field and had some cautionary notes on the properties of sea ice in nature as compared with ice used for modelling. He suggests warming the model ice just before testing. A full discussion of similar considerations is included and the 'Cauchy number' and 'Ice number' are introduced. Apparently these two parameters must be made equal in model and full scale tests in order to produce realistic results.

As an introduction to session C, Tienstra and Korringa of The Netherlands then presented a paper which described in rather alarming manner, the way fish stocks in certain areas have been depleted by industrial activity.

Horikawa presented an interesting paper on nearshore currents, a topic very important to drilling activities on the Canadian East coast.

In the last invited lecture Danys presented some views on the stability and failure of some full size structures under the influence of ice forces. He points out that at present theoretical formulae, laboratory testing of ice samples, model testing, and numerical models are not producing reliable results for practical design yet. He presented some surprising pictures of lightpiers and lighthouses in the St. Lawrence Waterway, showing how these structures have stood up to ice thrust forces.

*Session A*

Discussion of the topic of platform design was initiated by Carlsen and Vindvik who described the construction procedure for conventional Condeep concrete structures. The MONOPOD structure was then described and various soil models for the foundation were discussed including an incremental finite element (F.E.) model for an elastoplastic soil. The MONOCONE was discussed and the principle of its design explained, i.e. that the impinging ice is made to fail in flexure rather than by crushing, this reduces the thrust forces produced by the ice considerably. Floating structures were later discussed and a number of F.E. structural models described. Finally, a clear description of the formation and effect of rubble fields near artificial islands was given and concludes that consolidated ice protects the island only if the rubble field surrounding the island has a diameter greater than four times the island's diameter.

The section on port and ocean engineering contained some fairly conventional papers dealing with the response of moored systems. In Cuthbert and Seidi's paper, the MOSA computer code for this analysis, it was stated that the numerical results *give good comparison with model experiments*, although Eryuzlu and Biovin in the following paper, stated that the physical model of the same situation does not agree at all well with the MOSA calculations! The *combined* effects of currents and waves on moored structures are discussed from the results of a hydraulic model in Khanna's paper.

Harbours are then discussed fully and the concept and theory of the 'wave pump' is described. The wave pump is simply a channel which is shaped to use incoming wave energy to raise the water level in a reservoir. The potential energy stored may then be used to flush pollutants or ice from a harbour. Another method of ice removal is discussed which involved pumping the deeper warmer water to the surface.

The section on ocean engineering and marine transportation starts with a discussion of the various pipelaying techniques used in Arctic conditions including the deflection techniques where the conductor type is actually bent towards the wellhead on the sea floor. The papers on marine transportation include valuable data obtained from field studies of the ice forces on the hulls of vessels traversing ice covered waters. These ice forces were ingeniously obtained indirectly using strain gauges with the craft and a F.E. program to relate these to hull pressures. Direct mathematical model results have been shown to give too high results for these pressures because of the flawless quality of the ice assumed in these models.

*Session B*

The session on ice started with an interesting paper by Steltner which would be very useful for anyone setting out on a polar expedition. He sets out his experience of polar conditions and even gives a checklist of supplies and gives 'road tests' of methods of transport. The following paper is a description of the computer code AIDJEX which gives a good simulation of the velocity and deformation fields of ice using an elastoplastic material model. It is apparent from this study that the results are very sensitive to the ice strength used. These material parameters which determine ice motion are estimated fom actual observations in the following paper. Another F.E. program is then described by McGovern *et al.* which predicts the bearing strength of ice (PLATE). The paper describes investigations in the field, this work should be useful for anyone considering using the ice as a base for construction work.

Another important feature of polar ice is the existence of ice pressure ridges. Wadhams matches their theoretical height and slope distributions against observation. It is concluded that the current theories underestimate the number of ridges with deep keels, furthermore, observations suggest that such ridges seem to spread from a single origin.

The section on ice mechanics starts with a theoretical investigation of the impact forces needed to break a floating ice sheet when it collides with a sloping structure. The ice seems to behave like an elastic plate on an elastic foundation. The following paper presents a F.E. analysis of the same situation. The properties of ice under long term static loading (in a creep situation) are then described by the following three papers. Perhaps we shall be using ice as a structural material in the near future.

Ice forces on structures is the next topic to be considered, and it is pointed out that these loads can be dynamic due to the periodic cracking of the ice. Structural vibrations may result as the ice crushing strength decreases rapidly beyond a certain strain rate giving a negative damping effect which must be balanced with the positive damping of the structure. These considerations give rise to a useful stability criterion for structures in ice. The last paper in this section gives an excellent description of the ice force design considerations for conical offshore structures.

The section on icebergs contains studies of scour, iceberg motion (using a Morison-type equation) and discusses various methods of iceberg destruction. One novel method of ice destruction suggested is a chemical one involving the mixing of $SO_2$, $H_2$ or $NH_3Cl$ with the ice.

*Session C*

The Arctic environment is at present relatively unpolluted so environmental considerations are very important. In addition the low temperature results in a slow metabolic rate for the native organisms which would normally destroy an oil spill, thus allowing oil to remain in the environment for many years. This section contains a number of case studies and Hayes *et al.* have classified various types of coastline according to vulnerability to oil spill impact. There is also a description of a computer simulation for the behaviour of oil spills (OILSIM). It is also pointed out that oil may be entrapped in the ice and carried to distant regions to be released at some time later when the ice melts.

The section on physical oceanography includes a number of studies of the environment, e.g. wind, air temperature precipitation, visibility, ice climate and wave energy flux which should be useful for reference. One surprising feature is the variability in the coastline in certain regions due to changes in the mean sea level. There is even a map showing the iceberg density distributions by seas for the east coast.

Wave climate is also adequately discussed including Rossby waves which are only appreciable at these high latitudes. There is an interesting paper by Overvik and Houmb on the theoretical distribution of wave steepness which gives a good fit to the real world situation.

The session concludes with a survey of the techniques of remote sensing, including acoustic scanning, pulsed radar and satellite observation. The use of the new LANDSAT seems particularly promising for detailed surveying of floe sizes, fracture patterns, spacial and temporal frequency of ice concentrations as well as ice thickness observations. We are now in a position to predict with some confidence ice conditions, a five year periodicity of severity of freeze-up seems to have been confirmed.

The conference gave a very comprehensive picture of recent advances in the field of ocean engineering in the Arctic, and it is surprising how far we have gone towards solving the problems that this hostile environment presents. It will be interesting to see what further progress has been made by the time the next conference is held.

*S. Walker*

# CALENDAR

**12–25 January 1980**

Third Graduate School Ocean Transportation
*Delft, The Netherlands*
Secretariat of the third WEGEMT Summer School, Prof. ir. N. Dijkshoorn, Delft University of Technology, Mekelweg 2, 2628 CD Delft, The Netherlands

**19–22 February 1980**

Exhibition Channel Offshore '80
*Southampton, UK*
Solent Exhibition Ltd, Bournemouth Exhibition Centre, Stewart Road, Bournemouth, UK

**3–7 March 1980**

OI 80 – Advanced Technology for Offshore Industry
*Brighton, UK*
BPS Exhibitions Ltd, 4 Seaford Court, 220–222 Great Portland Street, London W1N 5HH, UK

**4–6 March 1980**

Petroleum Geology of the Continental Shelf of North West Europe
*London, UK*
Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, UK

**4–8 March 1980**

Oceanexpo '80
*Bordeaux, France*
8 rue de la Michodiere, 75002 Paris, France
Technoexpo S.A., 8 rue de la Michodiere, 75002 Paris, France

**5–7 March 1980**

3rd International symposium on Dredging technology
*Bordeaux, France*
Symposium Organiser, 3rd Dredging, BHRA Fluid Engineering, Cranfield, Bedford MK43 0AJ, UK

**23–29 March 1980**

17th International conference on Coastal engineering
*Sydney, Australia*
The Conference Manager, 17th ICEE, The Institution of Engineers, Australia, 11 National Circuit, Barton, 2600, Australia

**25–27 March 1980**

Recent advances in boundary element methods
*Southampton, UK*
Dr. C. Brebbia, Seminar Director, Department of Civil Engineering, University of Southampton, Southampton SO9 5NH, UK