Experimental Study of Concrete Resistance to Ice Abrasion

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ABSTRACT

Operation of concrete bases of gravitational type (CGBS) on a shelf of arctic seas with highly dynamical drift of an ice cover is interfaced to a set of problems. One of them is abrasion of the concrete structure followed by the hazard of outcrop of reinforcement and accelerated corrosion in marine environment, loss of width and strength of structural components.

Now there is no reasonable theory of calculation of the ice abrasion intensity, and consequently there are no requirements to concrete applied in conditions of the Arctic seas. That is why the ice laboratory and the experimental unit were created on the basis of Hydrotex Co., Ltd in order to study the intensity of ice abrasion of materials.

KEY WORDS: Abrasion, drifting ice, concrete, ice laboratory

INTRODUCTION

The sheet ice is known to cause considerable abrasive effect on surfaces of offshore hydraulic structures. The structure’s bearing capacity determined by material strength properties is significantly dependent on irreversible deformations and accumulated damage from actual ice load. Therefore, determination of intensity of offshore structure’s wear-out due to abrasive effect of drifting ice remains one of the topmost problems in areas of highly-dynamic ice drifting.

In turn, the intensity of ice abrasion depends on various factors: mainly contact pressure, length of abrasion path and resistance to ice abrasion of particular type of material. (Saeki at.al. 1987)

Evaluation of the contact pressure and abrasion path length requires an appropriate mathematical tool. Length of abrasion path is determined by the process of ice formations drift and interaction with the structure. Presently, no theoretical models specifying material resistance to ice abrasion are available. Experimental studies of various materials in terms of resistance to ice abrasion have led to determination of empirical dependence of ice abrasion intensity. Calculation of ice abrasion shall make allowance both for ice effect on the structure and ice abrasion resistance of the particular material. The joint use of theoretical model of interaction and empirical model of material deterioration makes it possible to develop a method of ice abrasion depth calculation.

METHODS OF EXPERIMENTAL STUDY

Main objective of the laboratory researches concerning the abrasion is to test the concrete samples and develop an empirical model of the ice abrasion, and to calculate an expected annual abrasion of a structure material by application of the developed empirical model.

In order to carry out the investigations, the abrasion installation and the ice laboratory are applied which allow to get ice with characteristics close to full-size.

The Installation for the Ice Abrasion Research

The main purpose of laboratory studies is to test concrete species in terms of ice abrasion and to develop the relevant empirical model of ice abrasion, which can be used as basis for calculation of annual abrasion of the structure’s material.

Such study requires an abrasion unit and special-purpose ice laboratory capable of generating ice with properties similar to natural. Ice abrasion test unit was designed and assembled by “NPO Hydrotex” Co. Ltd. Special-designed test unit specifications are as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Horizontal displacement range</td>
<td>2000 mm</td>
</tr>
<tr>
<td>Vertical displacement range</td>
<td>700 mm</td>
</tr>
<tr>
<td>Horizontal displacement velocity (adjustable)</td>
<td>0.2±1.0±0.2 m/s</td>
</tr>
<tr>
<td>Vertical displacement velocity (during positioning)</td>
<td>1.0±5.0 mm/s</td>
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<tr>
<td>Sample pressure strength</td>
<td>1.0±10.0 kN</td>
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Fig. 1 shows general view and configuration of the installation.