

A Cold Room Experimental Study on the EG/AD Model Ice Properties

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ABSTRACT.

The EG/AD/S model ice, originally developed by Timco (1986), was selected as the primary model ice material for the newly built MOERI Ice Model Basin in Korea. However the existence of sugar component in the EG/AD/S mixture may cause a serious maintenance problem as described in some references. This study focuses on the tests of mechanical properties of EG/AD/S and EG/AD model ice. In order to understand the influence of sugar in the original EG/AD/S model ice and to find a possible substitute for sugar, a series of tests with EG/AD model ice were performed and results were compared to those of EG/AD/S model ice.

The relatively large size of the MOERI Ice Model Basin made it difficult to control the initial strength of model ice and it took a much longer time to achieve the target strength. In order to obtain lower strength and stiffness for the model ice, the amount of chemical additives may be varied to achieve the desired strength level. This paper is a preliminary study aimed at seeking a possible substitute to the original EG/AD/S model ice for utilization in a large scale ice tank. To understand the influence of sugar in the original EG/AD/S model ice, the mechanical properties of EG/AD/S and EG/AD model ice, such as flexural strength, compressive strength and elastic modulus are tested in the laboratory condition and are compared to each other. The warm-up procedure seems to be an important factor to reduce ice strength in the tests and is discussed in detail.

KEY WORDS: Cold room; MOERI ice model basin; EG/AD model ice; Mechanical properties;

INTRODUCTION

Full-scale field measurements are important for construction of Arctic ships and offshore structures, however, the full-scale tests in ice-covered sea are usually very expensive and difficult. Model tests in a refrigerated ice model basin may substitute for full-scale field tests. One of the main issues while performing model tests in the ice model basin is to select a model ice material which follows the appropriate similitude law between the prototype and model scales. Among various material properties of model ice, the most important one is the

ratio of elastic modulus to flexural strength (E/σ_f) of model ice. Usually, E/σ_f ratio in the range of 2,000 ~ 5,000 is needed for model ice materials suitable in ice tanks (ITTC, 2002).

The first Korean ice model basin facilities were completed at the MOERI (Maritime and Ocean Engineering Research Institute) in late 2009, built to assess the ice performance and ice load estimation on ships and offshore structures in the Arctic environment. The MOERI ice model basin is equipped with a square type basin, which has a trimming tank, an X-Y type main carriage, a service carriage and a refrigerating system etc. The size of the main basin is 42m long by 32m wide by 2.5m deep. A 10m long by 32m wide trimming tank is separated from the ice sheet by a thermal barrier while the ice sheet is prepared. The collaboration between MOERI and NRC-IOT of Canada was influential in the decision to use EG/AD/S-CD type model ice in the new MOERI ice model basin. The MOERI ice model basin was to adapt the EG/AD/S model ice of NRC-IOT in the first stage because it may provide a good scaling of mechanical properties of columnar sea ice. However, it was reported that the sugar component of the EG/AD/S solutions may cause a maintenance problem due to organic bacteria; hence, the EG/AD model ice was later chosen for the MOERI ice model basin.

This paper focuses on the tests of mechanical properties of EG/AD/S and EG/AD model ice. In order to understand the influence of sugar in the original EG/AD/S model ice and to find a possible substitute for sugar, a series of tests with EG/AD model ice was performed and results were compared to those of EG/AD/S model ice. The mechanical properties of EG/AD model ice measured include flexural strength, compressive strength, elastic modulus and density.

PREPARATION OF MODEL ICE SPECIMEN

The ice tank was not available at the time of the experiment. A cold room facility was substituted for the model ice tests. The cold room designed for ice mechanics research was used to measure the elastic modulus and the flexural strength of EG/AD/S and EG/AD model ice. Details of the cold room facility were described by Choi et al. (2008). A digitally controlled universal testing machine (UTM), portable push-pull spring gauge and uni-axial compression test apparatus were used to