COMMENTARY ON THE TEST METHOD FOR ALKALI RESISTANCE OF CONTINUOUS FIBER REINFORCING MATERIALS (JSCE-E 538-1995)

INTRODUCTION

The need for the test for alkali resistance as a durability test for CFRM is referred to in Concrete Library No. 72 "Application of CFRM to Concrete Structures". The alkali resistance of CFRM is determined by immersing test pieces in an aqueous alkaline solution, noting any changes in external appearance, weight and tensile failure capacity before and after immersion, if necessary also conducting microscopic examination of the sides and sections of the test piece, as well as physical and chemical analyses of the fiber bond. The present test method references the following standards:

-JIS K 7107 "Testing Methods for Chemical Resistance of Plastics under Constant Tensile Deformation"
-JIS K 7108 "Testing Methods for Chemical Resistance of Plastics under Constant Tensile Load"
-JIS K 7114 "Testing Method for Evaluation of the Resistance of Plastics to Chemical Substances"
-JIS K 7209 "Testing Methods for Water and Boiling Water Absorption of Plastics"

1. SCOPE

The purpose of this test is to evaluate the alkali resistance of CFRM.

2. TEST PIECES

(Comment on 2.1) The length of the test section of test pieces is based on the proposed tensile test method. Test pieces which have clearly failed at or slipped out from the anchoring section are to be ignored, and test continued until the number of test pieces failing in the test section is not less than three. As there is a possibility of alkaline fluid infiltrating via the ends of the test piece, causing loss of strength in the CFRM, both ends are to be completely sealed with a strong alkali-resistant resin such as epoxy.

(Comment on 2.2) The epoxy sealed ends of a test piece that has undergone immersion are to be cut off, giving a test piece for measurement of mass change. Following measurement of mass change, the test piece is to undergo tensile test.

3. IMMERSION IN ALKALINE SOLUTION

(Comment on 3.1) The alkaline solution should be at around pH 13, e.g. $Ca(OH)_2$ = 2 g/*l*, NaOH = 10 g/*l*, KOH = 14 g/*l*. During long-term testing, there is a possibility of water in the alkaline solution

evaporating or absorbing CO_2 from the air, resulting in changes of composition and pH levels, as well as sedimentation. Immersion has therefore to be carried out in a sealed container. Any elution or reaction with the alkali on the part of the CFRM may be ignored, as the high pH level renders negligible the effects of elution or reaction on the pH level.

(Comment on 3.2) A high temperature is desirable as this is an acceleration test, but an upper limit of 60°C has to be imposed owing to the alkali-resistance properties of the fiber bond. 60°C is given as the standard immersion temperature, although any temperature in the range 20~60°C may be selected, depending on the expected application conditions and the properties of the CFRM. Temperature variation should be kept within ±2°C.

(Comment on 3.3) The test piece will normally be immersed untensioned, although immersion under tension is desirable if the material is intended for use as prestressing tendons.

(Comment on 3.4) The standard immersion period shall be 1 month, variable within the range 7 days ~ 1 year. For long periods of immersion, sampling test should be carried out during the test period.

4. EXTERNAL INSPECTION

Elution of the fiber bond into the alkaline solution may result in changes in the surface condition, color and geometry of the CFRM, therefore a visual comparison of immersed and non-immersed specimens is required. If more detailed inspection is necessary, the polished surface or section of the test piece is to be examined under an optical or electron microscope. A physical and/or chemical analysis of the matrix may also be required.

5. MASS CHANGE

The test piece is to be thoroughly washed after immersion to remove any alkali solution adhering to the surface or interior, and the hardened epoxy resin at the ends removed. The test piece is then dried to constant mass. Drying should preferably be carried out in a short time while avoiding thermal degradation, by drying in vacuum at a temperature of not more than 60°C. After leaving the test piece at normal temperature and humidity for 24 hours, the mass is to be measured to an accuracy of 0.1 g and the length to 1 mm. The mass and length of the test piece must of course also be measured prior to immersion.