Variation in creep rate at constant loading of PET geogrid strapping

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ABSTRACT: Creep tests have been executed on PET strapping material. The measurements were very precise which resulted in the recognition of different creep rate patterns at various loadings. This data allowed to further verify the molecular chain transformation model which has been established for PET yarns. Creep data from other tests were used to validate the model. A simple method has been proposed to calculate the creep during the service life of a PET reinforcing material using elastic strain, strain during the first 1,000 sec. and the constant creep rate in the rest of the service life. This paper gives additional support to the model of creep deformation at molecular level which is developed in our other paper at this conference (Residual strength of PET after more than 12 years creep loading) and which is based on the stress-strain model developed by Van den Heuvel.

1. INTRODUCTION

The creep of polymer material has been investigated by many researchers in the past 25 years. A lot of effort has been put in the transfer of the creep data into design rules. Colbond Geosynthetics has been active in the research on creep on PET material since 1975. Many papers have been published on creep programs which we have executed, at that time under our previous name Akzo Nobel Geosynthetics (Den Hoedt, G., 1986; Viezee D.J. c.s., 1990). This all has let to much better insight in the magnitude of creep and the use of these phenomena in design. Creep ends in rupture and the use of a stress-rupture line for design for certain service lifetime has become a standard design tool (Voskamp W., 1985).

Nowadays it is normal practice to execute prolonged loading tests in accordance with the applicable standards and measure the creep up till 10,000 hrs. The loads are taken at higher levels to allow for rupture during the test period. Preferably the loads have to be at at least 3 different levels to allow a reliable extrapolation of the line drawn through all rupture points: the stress-rupture line. Extrapolation is done over 1 or 2 decades. Because creep testing executed in the conventional way takes a very long time, methods have been developed to speed up the process. First Time Temperature Superposition (TTS) became in use. This method uses the concept that increasing temperatures accelerate the creep rate, thus the time for the creep to develop is reduced. Creep curves are shifted and lead to a master curve which is used for extrapolation. In the last years a new method has been published: Stepped Isothermal Method (SIM) (Thornton, J.S. c.s., 1997). Since 1987 an extensive creep measuring program is being executed at the Colbond Geosynthetics laboratory which has given interesting results. In this paper the results of our creep program on PET straps are published. These very detailed readings gave insight in the variation of creep rates at various levels and showed some surprising results.

2 DESCRIPTION OF THE TEST

Creep tests have been executed at samples taken from our newly developed Enkagrid material. This geogrid consists of continuous straps which are connected to each other by means of a laser welding technique. The production method has been described by W. Voskamp, 2000. The tests were made at samples, one strap wide, creep was measured with an optical device resulting in accuracy in reading of 0,01 mm or 0,033%. The tests were executed in accordance with EN-ISO-13431, sample length between measuring points was