

Thermal resistance of geopolymer

Technical specification: 07

Summary

The thermal resistance is measured with a dimensional stability test and Dynamic Mechanical Thermal Analysis (DMTA) analysis. The (Geobear) geopolymer is dimensional stable between -20 °C and 130 °C. At a certain temperature the material will lose mechanical properties and will start to degrade. This reduction in stiffness is depending on the system and applied density. Based on averaged soil temperature of 10 °C at a depth of 1 meter (3), the Geobear geopolymer fits the safe temperature range.

1. Introduction

Using the Geobear method, heavy structures are raised and re-supported by using the expansive force of plural component resins. The mechanical properties of the supporting soils are improved either as a consequence of the level correction works, or when required, by a targeted ground improvement application.

The Geobear Resins are the result of more than 35 years of continuous collaboration between Geobear and material suppliers.

The material properties can change under extreme temperatures. By increasing the temperature, the stiffness of the geopolymer will reduce. At a certain temperature the Geobear Geopolymer will lose mechanical properties and start to degrade. At lower temperatures the Geobear geopolymer starts to become brittle. The degree of degradation depends on the exposure time: At a short exposure time the degree of degradation will be lower.

2. Theory

Geobear geopolymers are thermo hardened materials. Therefore they will hold mechanical properties after heating, this due to the chemical bonds between individual building blocks of the geopolymer forming a three-dimensional network.

Because of the structure of the geopolymers, the material will not flow after heating and the mechanical properties will not change until a certain temperature.

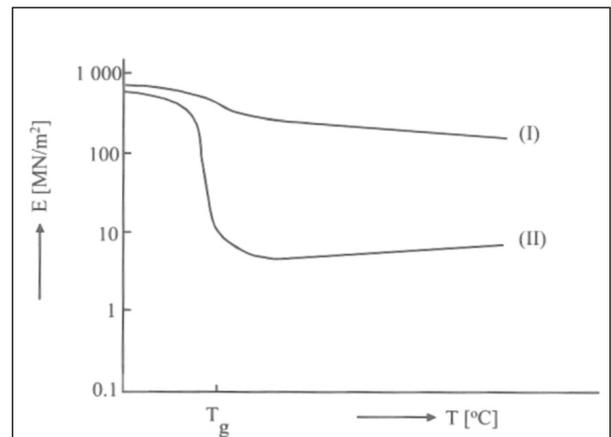


Figure 1: Elasticity modulus as a function of temperature for a thermo-hardened material (fine distributed network like the Geobear Geopolymers I) and a rubber (wide distributed network II) (1).

Above a certain temperature the mechanical properties will decrease which is caused by breakage of chemical bondages, due to thermal degradation. Geopolymers normally start to degrade between 150 °C and 200 °C. The self-ignition temperature of the Geobear Geopolymers is approximately 420 °C (2).

3. Experiment

Geobear Geopolymers are tested on dimensional stability at temperatures of -25 °C and 100 °C for 24 hours. The deformation of the Geobear Geopolymer is measured and should not exceed 5% at free rise density. The deformation is depending on the anisotropy of the foam cells. In figure 2 the typical types of deformation is shown of a dimensional stability test of the Geobear Geopolymer.

The mechanical properties depending on temperature can be evaluated with a DMTA (Dynamic Mechanical Thermal Analysis). With a DMTA analysis the mechanical properties are evaluated by loading and unloading the Geobear Geopolymer while increasing the temperature (DIN ISO 6721 B: 1996-12).

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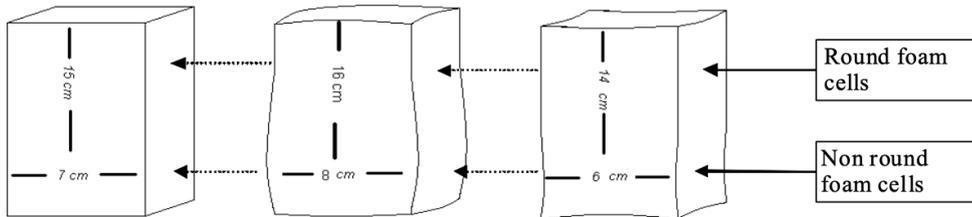


Figure 2: The typical deformation depending on the anisotropy of the cells

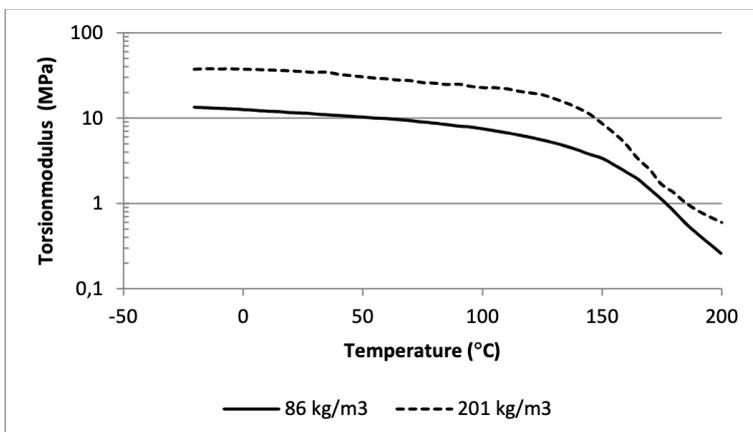
4. Results

The Geobear Geopolymers are dimensionally stable (< 5% deformation) and do not show any thermal degradation on the standard evaluated interval from -25 till 100 °C. The dimensional stability at an applied density is better because of the increase of density.

A specific Geobear geopolymer is evaluated with a DMTA analysis at a temperature range of -20 °C till 200 °C. The results are shown in figure 3.

This Geobear Geopolymer is resistant to temperature within a range of -20 °C to approximately 130 °C, with good mechanical properties. At higher temperatures the mechanical properties drop dramatically.

Figure 3: DMTA evaluation of the Geobear Geopolymer produced with Geobear Resin 2409 at the temperature range from -20 °C till +200 °C



5. Discussion and Conclusions

At higher temperatures the stiffness of the Geobear Geopolymers reduces. At a certain temperature the material will lose mechanical properties and starts to degrade. For the Geobear Geopolymer produced with Geobear Resin 2409 this is at approximately 130 °C.

This reduction in stiffness is depending on the system and applied density. Based on averaged soil temperature of 10 °C at a depth of 1 meter (3), the Geobear Geopolymer fits the safe temperature range.

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