Durability technical fibres in alkaline environment

Martina Ryvolová[1]

[1] *Technical University of Liberec, Institute for Nanomaterials, Advanced Technology and Innovation,*
e-mail: martina.ryvolova@tul.cz

Abstract: Textile Reinforced Geopolymer Composites (TRG) are an alternative to traditional reinforced concrete. TRGs offer advantages in terms of mechanical and thermal properties. Still, their applicability is extended, e.g., due to their resistance to aggressive environments or ability to bind heavy metal-based wastes. Last but not least, TRG structures bring weight and financial savings.

This paper focuses on the resistance of technical fibers in highly alkaline environments. Fiber rovings were exposed to strongly alkaline liquids at RT for a long time. The degree of damage was evaluated by monitoring weight loss and changes in tensile strength, as well as by scanning electron microscopy (SEM). The experimental results confirmed the available and accepted knowledge on the effect of alkaline environments on carbon, basalt, and glass fibers. The paper contribution is the description of the behavior of mainly glass fibers treated with water glass, which simulates the environment of a geopolymer matrix.

Keywords: *glass fibers, basalt, carbon, anticorrosion, durability, alkaline treatment.*

INTRODUCTION

Technical materials include carbon, glass, basalt, aramid, and some synthetic fibers such as polyester. Carbon fibers clearly show the best chemical resistance in alkaline environments. The surface reactivity of carbon fibers can be enhanced by oxidation above 100 °C in the presence of concentrated HCl or HNO_3. This results in streaking or roughening of the surface. [1].

The effect of alkaline environments (most commonly NaOH solutions with different concentrations) on basalt fibers is well described. As a result of the breaking of the Si-O-Si bond by the action of OH-, the formed silicates migrate into the solution, and corroded areas appear on the fiber surface. A porous gel layer is formed in these regions; metallic compounds Fe, Ca, and Mg are bound, and hydroxides are diffused from the fiber core under the gel layer. [2-5]

The length of exposure time increases the frequency of particles, and the particles gradually aggregate into flake-like formations. A brittle deposition layer (called a corrosion shell) grows. In addition, minor damage to the surface of the fibers is caused by production and subsequent handling. Water molecules produced by chemical reactions cause the surface layer to swell and increase in volume. Over time, the deposition layer completely covers the gel layer, increasing the area and thickness of the corrosion shell. The process closely relates to changes in fiber diameter, weight, and tensile strength. [2-5] The most commonly used E-type glass fibers behave similarly [1, 6].

RESULTS

Fiber rovings were treated with $Ca(OH)_2$ and potassium water glass (LK) at RT for 52 weeks. At intervals, the cleaned and dried samples were weighed, tensile strength tests were performed (results for E-glass fibers are presented in Table 1), and SEM analysis of the fiber surface was performed (Fig. 1).

Table 1 Tensile strength test results of E-glass rovings

Exp. time	$Ca(OH)_2$	LK
W0	829,6±116,42	829,6±116,42
W2	153,70±49,53	27,87±12,64
W13	129,81±65,63	23,74±16,49
W26	16,53±4,99	-

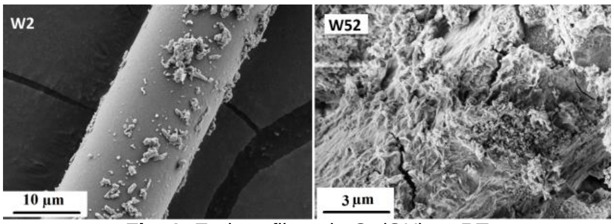

Fig. 1: E-glass fibers in $Ca(OH)_2$ at RT

REFERENCES

[1] COUSIN, P. at all. *Chemical resistance of carbon, basalt, and glass fibers used in FRP reinforcing bars*. doi:10.1177/0021998319844306..

[2] SCHEFFLER, C. at all*. Aging of alkali-resistant glass and basalt fibers in alkaline solutions: Evaluation of the failure stress by Weibull distribution function.* doi: 10.1016/j.jnoncrysol.2009.09.018.

[3] WANG, Q., Y. DING a N. RANDL. *Investigation on the alkali resistance of basalt fiber and its textile in different alkaline environments.* doi: 10.1016/j.conbuildmat.2020.121670.

[4] TANG, Chunhong, at all*. Corrosion Behavior and Mechanism of Basalt Fibers in Sodium Hydroxide Solution.* doi:10.3390/ma11081381.

[5] YING, Shuni a Xiaodong ZHOU. *Chemical and thermal resistance of basalt fiber in inclement environments.* doi:10.1007/s11595-013-0731-4.

[6] LI, Meng at all. *Variation on the morphology and tensile strength of basalt fiber processed in alkali solutions.* doi: 10.1016/j.conbuildmat.2022.127512

[7] KOPECSKÓ, Katalin. *Durability of glass fibers*. Symposium on Fibre-Reinforced Concretes (FRC), Varenna, Italy. 2004.