UNIVERSITÉ DE SHERBROOKE

NSERC Research Chair in Innovative FRP Composite Materials for Infrastructures

Alkali Resistance in High pH Solution of #5 V-ROD GFRP Reinforcing Bars

Technical Report

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1. INTRODUCTION

The main objective of this study is to evaluate the alkali resistance in high pH, with load and without load, of #5 (diameter 15.9 mm) of GFRP V-ROD reinforcing bars according to ISIS Product Certification document (ISIS, 2006). The alkali resistance is measured by subjecting the GFRP bars to an alkali environment, without and with stress, and elevated temperature for a test duration of 3 months according to ISIS Document on Specifications for Product Certification of FRPs as Internal Reinforcement in Concrete Structures (2006).

2. MATERIALS

Sand coated GFRP V-ROD reinforcing bars manufactured by Pultrall Inc. (Thetford Mines, Quebec, Canada) were used in this study. The bars were made of continuous E glass fibres impregnated in a vinylester resin using the pultrusion process. The used GFRP bars have a nominal diameter 15.9 mm (#5). Five samples from the same lot were tested as specified by ISIS Product Certification document (ISIS, 2006). The ultimate tensile strength of the GFRP bars used in this study was equal to 611±15 MPa.

3. TEST METHOD

The alkali resistance of GFRP reinforcing bars was conducted according to ACI 440.3R-04 Test Method B.6 "Accelerated Test Method for Alkali Resistance of FRP Bars"- Procedure A (specimens with load), Procedure B (specimens with load), and then testing them in tension according to ACI 440.3R-04 Test Method B.2 "Test Method for Longitudinal Tensile Properties of FRP Bars". The primary test result is the tensile capacity retention of the test specimen. The GFRP bars were immersed in alkaline solution with a high pH of 12.8 at 60^{o}C for 90 days in accordance with ACI 440.3R-04 guide (B.6 Test Method). The conditioning was conducted on samples without sustained tensile load (Procedure A) and on specimens under a sustained tensile load (Procedure B) set to induce a tensile strain equal to 3000 micro-strain.

4. TEST RESULTS

4.1 Residual Tensile Strength

Tables 1 and 2 present the experimental residual tensile strength results for specimens after exposure to alkaline solution for 90 days with and without sustained load, respectively. The average residual tensile strength represents the average of 5 samples from the same lot.

The 15.9 mm diameter GFRP bars subjected to alkaline solution of high pH at 60^{o}C during 90 days showed a loss of 16 and 20 %, when aged with and without load, respectively. The residual tensile strengths of specimens aged with and without load are above the specified limits of ISIS Product Certification document (ISIS, 2006), which are set to 80 and 70% of the UTS, respectively.

Table 1. Residual tensile strength for 15.9 mm diameter V-ROD GFRP bars conditioned in high pH alkaline solution (without load)

Condition	Temp. (^{o}C)	Duration (days)	Residual tensile strength (MPa)	% of the reference UTS
Reference			611±15	100
Alkaline	60	90	525	86
			509	83
			511	84
			504	82
			518	85
Average			513±9	84±2

Table 2. Residual tensile strength for 15.9 mm diameter GFRP bars conditioned in high pH alkaline solution (with load)

Condition	Temp. (^{o}C)	Duration (days)	Elastic Strain (με)	Residual tensile strength (MPa)	% of the reference UTS
Reference				611±15	100
alkaline	60	90	3000	489	78
				471	77
				513	84
				495	81
				501	82
Average				494±16	80±3

5. CONCLUDING REMARKS

The obtained results lead to the conclusion that the 15.9 mm diameter GFRP V-ROD reinforcing bar manufactured by Pultrall Inc. (Thetford Mines, Canada) are resistant to alkaline environments and meets the requirements for certification according to ISIS Product Certification document (ISIS, 2006). .

6. REFERENCES

ACI 440.3R-04 (2004) "Guide Test Methods for Fiber-Reinforced Polymers (FRPs) for Reinforcing or Strengthening Concrete Structures", American Concrete Institute Committee 440.

ISIS (2006) “Specifications for Product Certification of Fibre Reinforced Polymers (FRPs) as Internal Reinforcement in Concrete Structures”, ISIS Canada Research Network.