

Longitudinal and Transverse Coefficients of Thermal Expansion of Aslan GFRP Rebars

Technical report



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INTRODUCTION

Aslan GFRP bars No. 2, No. 3, No. 4, No. 5, No. 6, No. 7, No. 8, and No. 10 manufactured by Hughes Brothers Inc. (Seward, Nebraska, USA) were shipped to the NSERC Industrial Research Chair in Innovative FRP Reinforcement for Concrete Infrastructures (Prof. Brahim Benmokrane) at the Department of Civil Engineering at the University of Sherbrooke in September, 2011 to determine their longitudinal (L) and transverse (T) coefficients of thermal expansion (CTE). Figure 1 shows the tested Aslan GFRP bars. The CTEs were determined according to ASTM E831-06 (2006) as specified by the CAN/CSA S807-10 (2010). The results were compared with the limit of CAN/CSA S807-10 (2010).

This report presents the LCTE and TCTE for the GFRP bars No. 2, No. 3, No. 5, No. 7, and No. 10 resulted from the tests conducted at materials/structure laboratory of the Department of Civil Engineering, University of Sherbrooke under the supervision of Dr. Brahim Benmokrane.



Figure 1: Tested Aslan GFRP bars No. 2, No. 3, No. 4, No. 5, No. 6, No. 7, No. 8, and No. 10

TESTING PROCEDURES AND RESULTS

The transverse and longitudinal coefficients of thermal expansion were determined according to the ASTM E831-06 (2006) using a TMA apparatus. Samples of 5-to 10-mm-thick were placed

under the probe and the measurements were conducted between -30° and 60°C with a heating rate of $3^{\circ}\text{C}/\text{min}$. The measurements were conducted on a minimum of three samples for each GFRP bar diameter. The tests of GFRP bars No. 2, No. 3, No. 5, No. 7, and No. 10 were completed and presented herein.

Table 1 provides the TCTE for the tested Aslan GFRP bars. The average transverse coefficient of thermal expansion (TCTE) ranged from 30 to $33 \times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$. The GFRP bars No. 2, No. 3, No. 5, No. 7, and No. 10 meet the CSA S807-10 (2010) limit for the TCTE which is $40.10^{-6} \text{ }^{\circ}\text{C}^{-1}$.

On the other hand, Table 2 presents the LCTE of the tested Aslan GFRP bars No. 2, No. 3, No. 5, No. 7, and No. 10. The LCTE ranged from 7.6 to $9.2 \text{ }^{\circ}\text{C}^{-1}$. To date, no specified limit is required for the LCTE value.

Table 1: Transverse CTE ($\times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$) of the tested Aslan GFRP bars

Sample	Transverse CTE ($\times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$)							
	#2	#3	#4	#5	#6	#7	#8	#10
1	35.9	30.7	-	30.5	-	33.5	-	32.1
2	27.6	30.6	-	32.4	-	33.3	-	33.1
3	27.1	28.5	-	30.3	-	33.0	-	31.5
Average	30.2	29.9	-	31.7	-	33.3	-	32.2

Table 2: Longitudinal CTE ($\times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$) of the tested Aslan GFRP bars

Sample	Longitudinal CTE ($\times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$)							
	#2	#3	#4	#5	#6	#7	#8	#10
1	10.3	8.0	-	7.3	-	8.0	-	12.6
2	10.7	8.5	-	7.2	-	8.0	-	6.5
3	6.5	8.4	-	8.5	-	8.9	-	7.5
Average	9.2	8.3	-	7.6	-	8.3	-	8.9

CONCLUSION

This study reports the coefficients of thermal expansion of Aslan GFRP bars No. 2, No. 3, No. 5, No. 7, and No. 10 manufactured by Hughes Brothers Inc. (USA). The average transverse coefficient of thermal expansion (TCTE) ranged from 30 to $33 \times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$ which meets the CSA S807-10 (2010) limit of $40.10^{-6} \text{ }^{\circ}\text{C}^{-1}$. The longitudinal coefficients of thermal expansion ranged from 7.6 to $9.2 \text{ }^{\circ}\text{C}^{-1}$.

REFERENCES

1. ASTM E831-06, 2006, "Linear Thermal Expansion of Solids Materials by Thermo-mechanical Analysis (TMA)," American Society for Testing and Material, Conshohocken, USA, 5 pp.
2. CAN/CSA-S807-10, 2010, "Specification for fiber-reinforced polymers," Canadian Standards Association, Rexdale, Ontario, Canada, 27 pp.