Fast Building – Increasing the Geometrical Freedom of Textile Reinforced Concrete Systems

Filipa B. Monteiro[1(*)], Fábio Cruz[1], Rita Neves[1], Diddyer Barajas[1], J.L. Rocha[2], Eduardo B. Pereira[1], Andrea Zille[3]

[1] Department of Civil engineering University of Minho Guimaraes, Portugal

[2] MEMS-UMinho, University of Minho, Campus de Azurém, 4800-058 Guimarães, Portugal

[3] Centre for Textile Science and Technology (2C2T), Department of Textile Engineering, University of Minho, Campus of Azurém, 4800-058 Guimarães, Portugal

Author contact: fmonteiro@civil.uminho.pt

Universidade do Minho

Content

- Introduction
- Objectives
- Textile preforms & Filling
- Experimental
- Results

Introduction

Textile technology is highly innovative, and several techniques are already being used to act as building parts for fast building, interior design, architectural details and offshore structures. However, such potential still fails when complex geometrical structures or multifunctionality are required.

CNC knitted preforms can act as structural exoskeleton, exploring differentiated benefits like:

- ✓ Multimaterial surfaces (natural and synthetic fibers),
- ✓ Multifunctionality (support, aesthetics, sensors, etc),
- ✓ Multi-shaped (possibility for complex non continuous geometries) multi-surfaces (patterns, volumes, etc.).

This work shows how design and fabrication of weft knitted preforms can act as structural parts for fast building technologies with increased geometrical complexity.

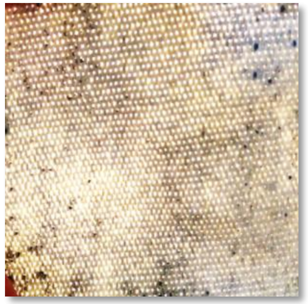
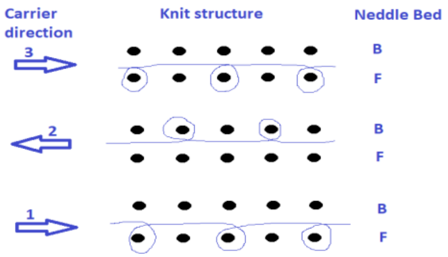
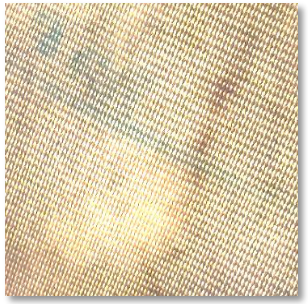
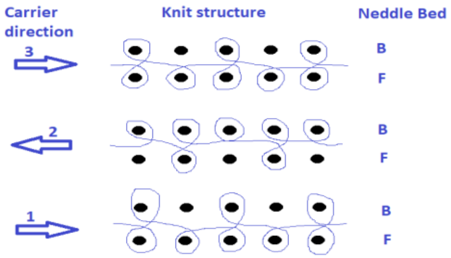
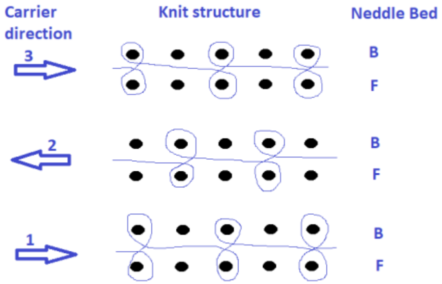
Objectives

Development of a system that could allow to built more complex concrete-based structures.

a) Increase the geometrical complexity of building parts using textile preforms - reducing costs and waste; multi-shaped and multi-material surfaces.

b) Withdraw casting procedures during filling: Integrative solutions on knitting technology; Integration of multifunctional details; development of complex macro geometries.

Textile Preforms & Filling

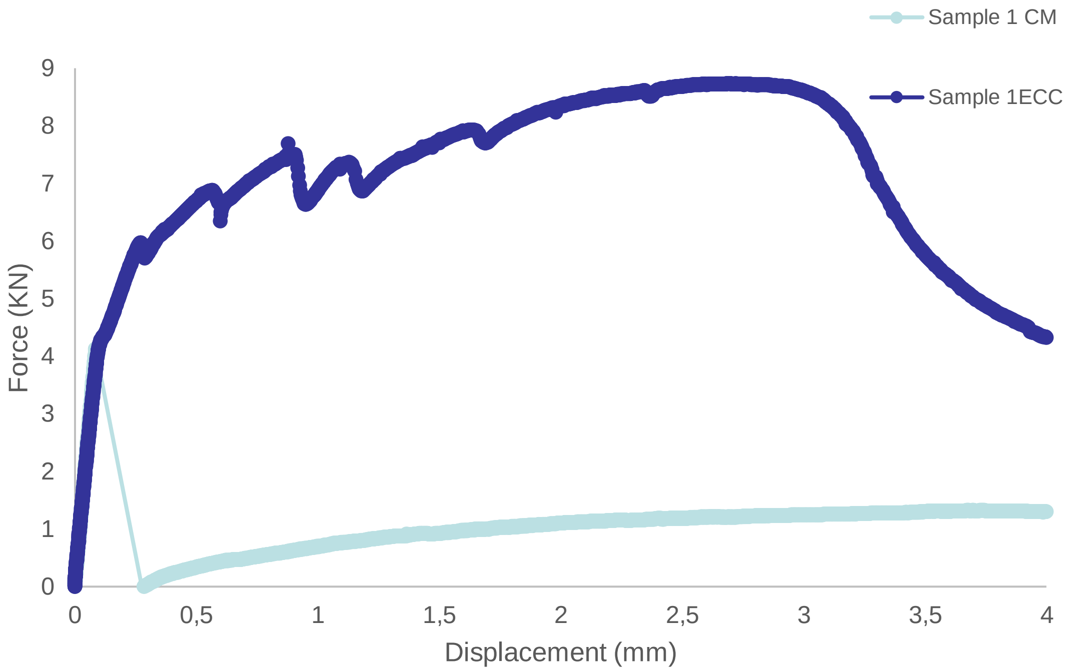
	TPs picture after filling and curing with cement matrix	TPs knitting scheme
TP1		
TP2		
TP3		

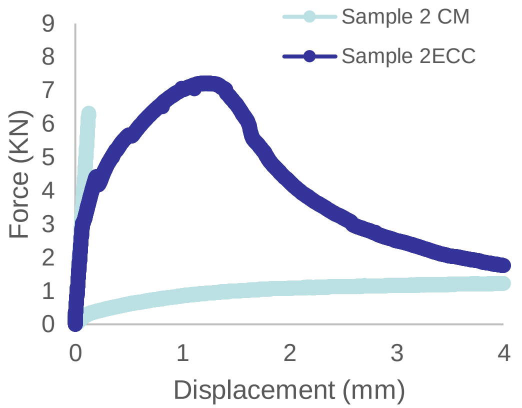
Concrete matrix composition

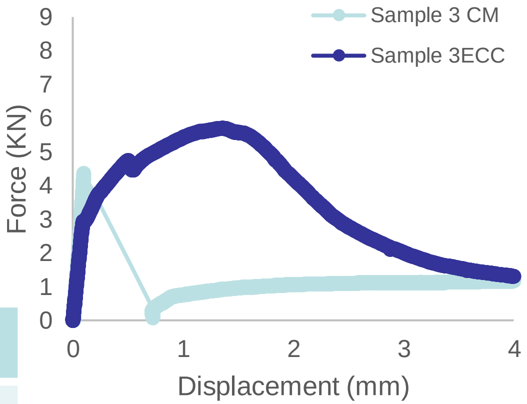
	CM		ECC	
	M (%)	M (Kg)	M (%)	M (Kg)
Cement	21,43	12,01	21,43	12,01
Fly Ashes (FA)	42,86	24,03	42,86	24,03
Sand	7,50	4,21	7,50	4,21
Limestone Filler	7,50	4,21	7,50	4,21
Water	18,48	10,36	18,48	10,36
SP Sika 3002 HE	0,80	0,45	0,80	0,45
VMA	0,02	0,01	0,02	0,01
PVA fibre	(NA)	(NA)	1,39	0,78

Experimental setup - 1st Trial

High Density Polyester (HDPES)

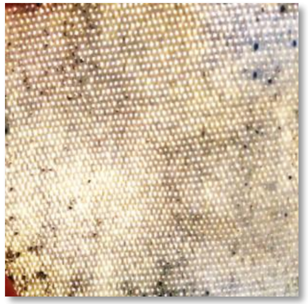
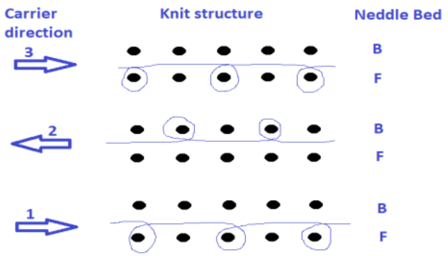
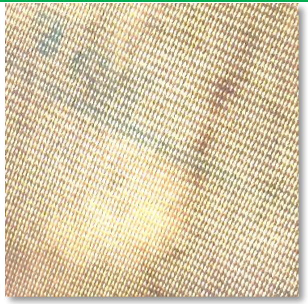
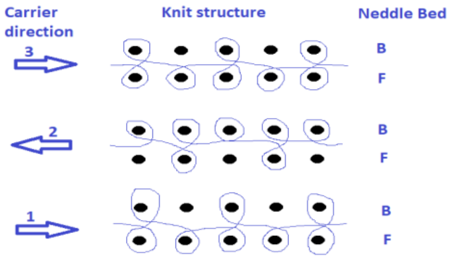
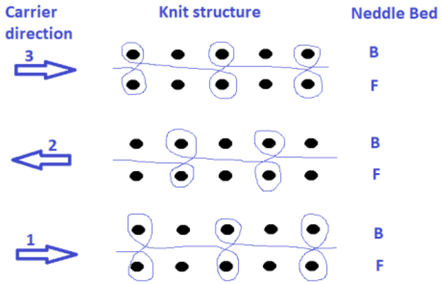






Sample	Structure	Weight (g)	Dimensions (cm)
TP1	Interlock	195	Ø 10 L 100
TP2	Interleaved fluctuations	320	
TP3	“Locked”	310	

Textile Preforms & Filling

	TPs picture after filling and	TPs knitting scheme
TP1		
TP2		
TP3		

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Experimental setup – 2nd Trial

High Density Polyester (HDPES)

2nd Trial attempted to withdraw casting by using the textile Design to incorporate internal support threads that allow to control samples volume during filling and curing.

This trial failed for the elements could not stand the pressure caused by the concrete filling.

Experimental setup – 3rd Trial

HDPES + Hemp

Two set of samples were produced in order to reinforce internal support threads:

1 – 100% Hemp: external structure and internal support threads.

2 – HDPES + Hemp: on external structure and internal support threads, respectively.

Results

- 1st Trial revealed that the textile preform had significant contribution, not on the mechanical performance itself, but mostly after matrix fracture where the preform prevented the system to collapse.

  Tensile properties were only tested o the 1st trial due to their respective homogeneous geometry, nevertheless it was possible to learn that less dense textile structures have greater results when compared to higher densities.

- 2nd Trial used the lessons learned from the 1st trial and less dense textile structures were produced, however, the advances made on this trial served to test free filling by adding internal support threads to control sample volume. HDPES was used on both external and internal textile parts and the results showed that internal support threads composed by HDPES could not stand the pressure caused by the filling process.

- 3rd Trial attempted to reinforce the internal support threads by using Hemp and the results show that Hemp is a good choice of material for such purpose. A second sample was also tested o this trial – 100% Hemp – showing that using this material on the outer part of the textile preform increased the porosity causing the concrete to escape during fresh state.

Overall, from 1st to 3rd Trials, the objective was achieved by increasing geometrical complexity of the building parts without compromising mechanical performance. Knitted textile design and production showed that promising results could be achieved when facing volumetric control and surface details.

Thank you

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