



TECHNICAL UNIVERSITY OF LIBEREC
Faculty of Mechanical Engineering ■

EVALUATION OF REINFORCING EFFICIENCY OF TEXTILE MESHES IN GEOPOLYMER MORTAR BASED COMPOSITE

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Department: **Material Science**

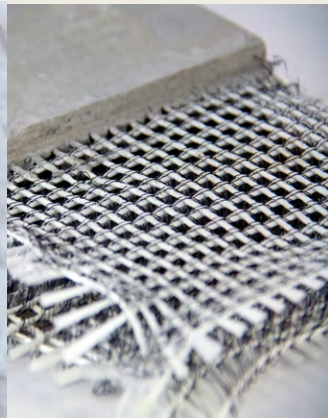
GeopolymerCamp 2019



Outline

- Introduction
- Materials & Sample Preparation
- Experimental Results
- Conclusions

Introduction - Textile reinforced concrete



- New thin-wall elements.

- Load-bearing elements in new structures.



- Repairing and/or strengthening the structural elements of old structures.

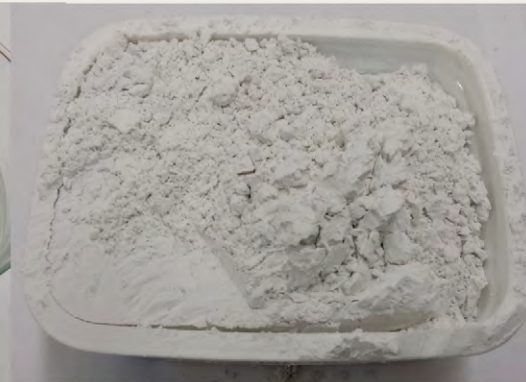
Materials & Sample Preparation

Chemical composition of geopolymer cement provided by Ceske Lupkove Zavody, Czech Republic.

Al ₂ O ₃	41.10
SiO ₂	54.10
K ₂ O	0.80
Fe ₂ O ₃	1.10
TiO ₂	0.80
MgO	0.18
CaO	0.13
LOI (loss of ignition) %	2.2



Geopolymer & sodium alkali solution



micro-silica sand: ≤ 0.063 mm



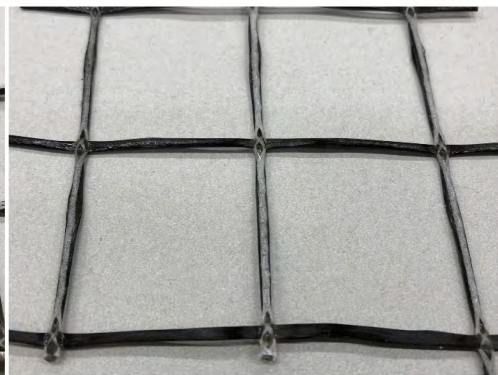
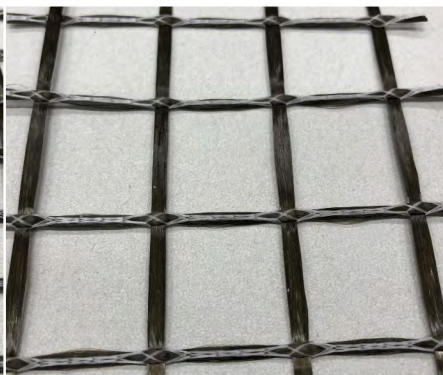
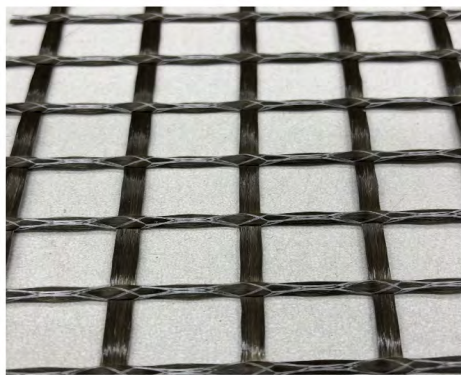
silica fume



rough silica sand: 0.6-1.25 mm

Chemical composition of silica fume as follow (wt.%): SiO₂ – 90, CaO – 0.8, MgO – max. 1.5, Al₂O₃ – max. 1, Na₂O – 0.5

Basalt meshes provided by Frisiverto S.R.O company, Czech Republic



Net size of 10 x 14 mm

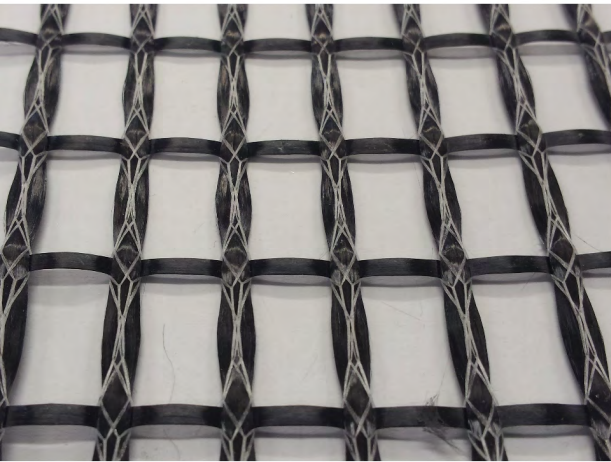
Net size of 22 x 22 mm

Net size of 36 x 36 mm

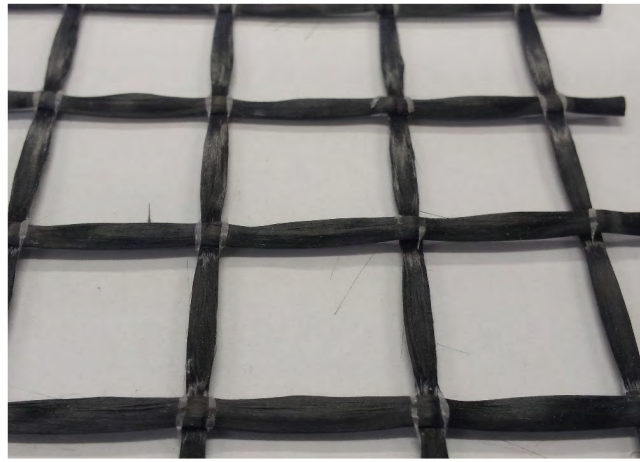
Chopped Basalt Fiber

Material characteristic		10x14	22x22	36x36
Tensile strength (MPa)	Lengthways	1335	1068	1141
	crossways	1251	1347	1279
Elongation (%)	Lengthways	1.86	1.61	1.62
	Crossways	1.50	1.63	1.54
Material	Lengthways	2400 Tex	2400 Tex	2400 Tex
	Crossways	2400 Tex	2400 Tex	2400 Tex
Binder yarn		PP 110tex		
Density (kg/m ³)		2.75		

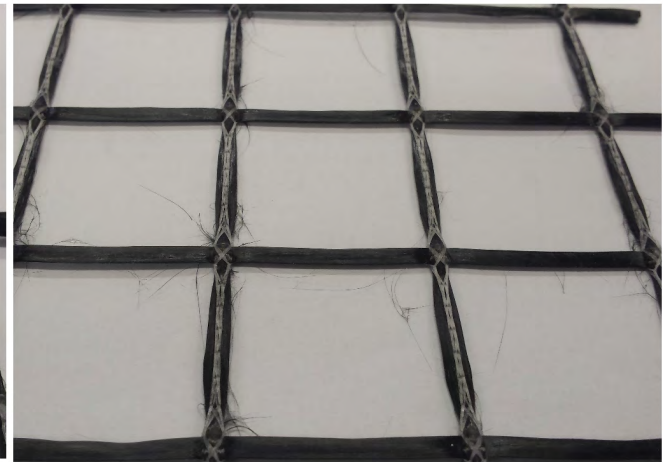
Carbon mesh provided by Frisiverto S.R.O company, Czech Republic



Net size of 10x15 mm



Net size of 22x22 mm



Net size of 34x34 mm

Material characteristic		10x15	22x22	34x34
Tensile strength (MPa)	Lengthways	2551	2531	2544
	crossways	2847	2841	2720
Elongation (%)	Lengthways	1.17	1.71	1.47
	Crossways	1.24	1.47	1.34
Material	Lengthways	48000 Tex	48000 Tex	48000 Tex
	Crossways	12000 Tex	48000 Tex	48000 Tex
Binder yarn		PP 110tex		
Density (kg/m ³)		1.80		

Process of specimen preparation

Geopolymer mortar is mixed in the following order: **1.** blending geopolymer cement + alkali solution; **2.** adding silica fume and micro sand; **3.** adding chopped basalt fiber and rough sand.



By weigh ratio (-)					BF content (wt % of geopolymer resin)
Geopolymer binder	Alkali solution	Micro silica	Micro sand	Rough sand	
1	0.8	0.1	0.2	1.5	0, 3, 5, 7.5

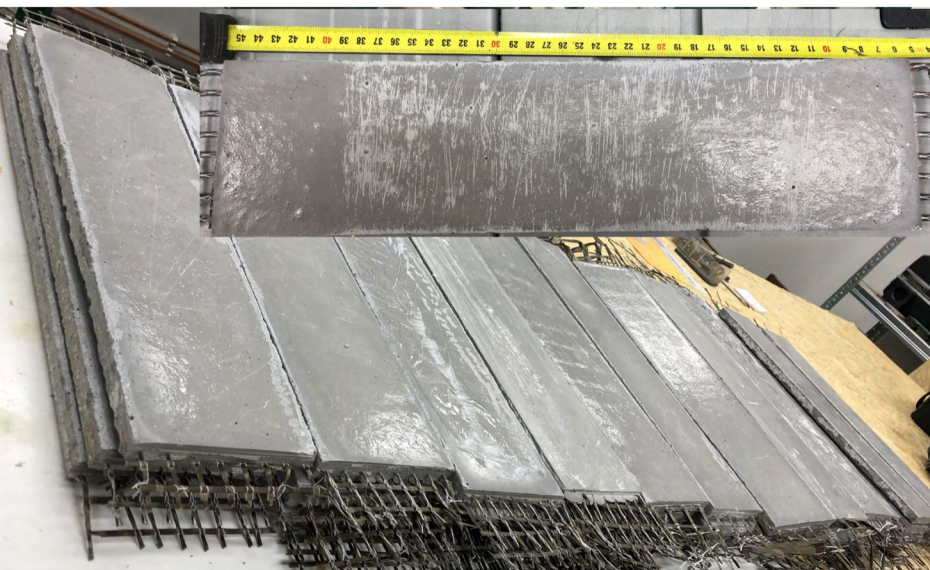
Process of specimen preparation



Molds with dimension 400 x 100 x 15 mm



Hand lay-up method



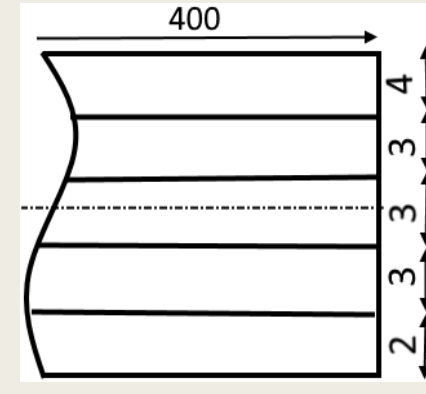
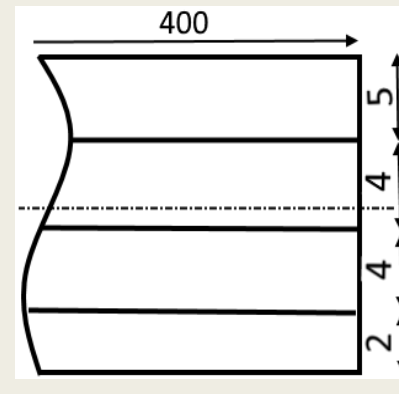
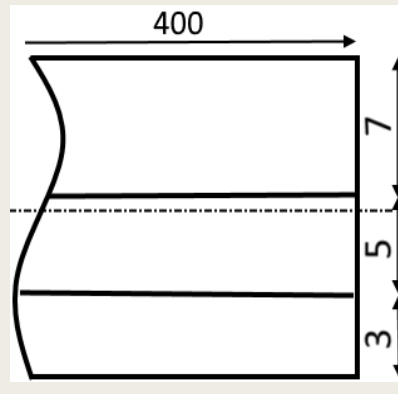
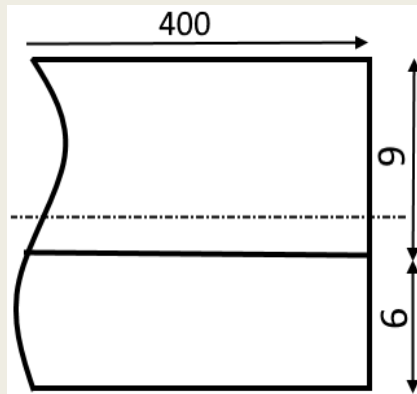
28 day specimens ready for test



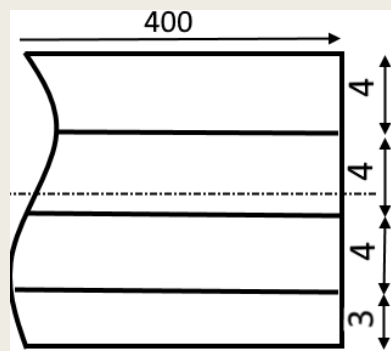
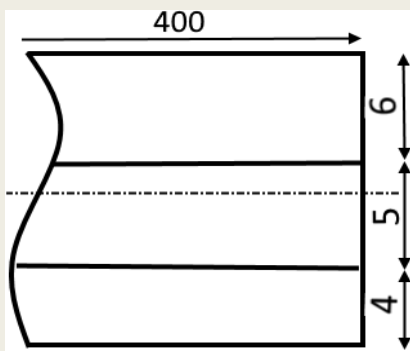
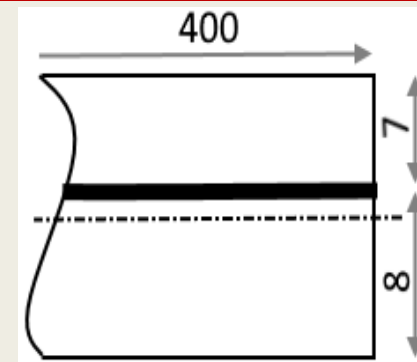
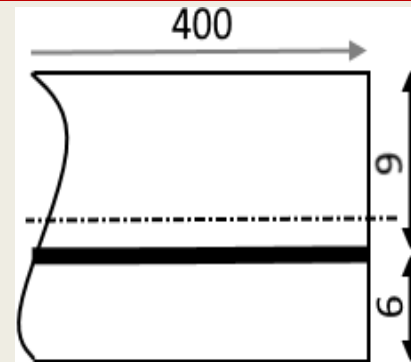
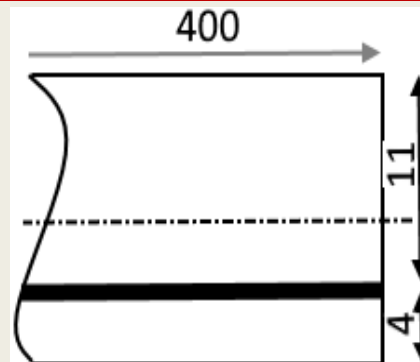
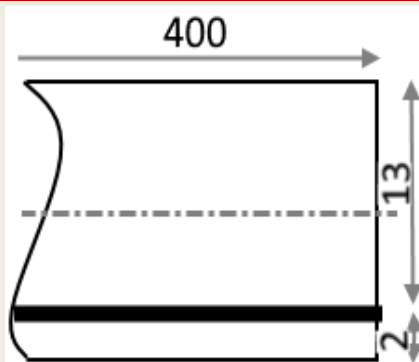
Cover using a polypropylen film

Layout of basalt fiber meshes :

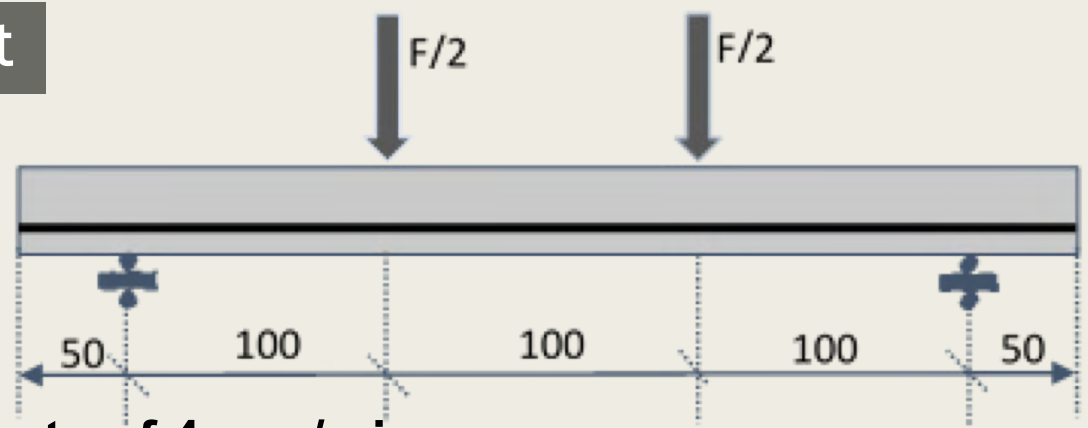
1 – 4 layers was reinforced in specimens.



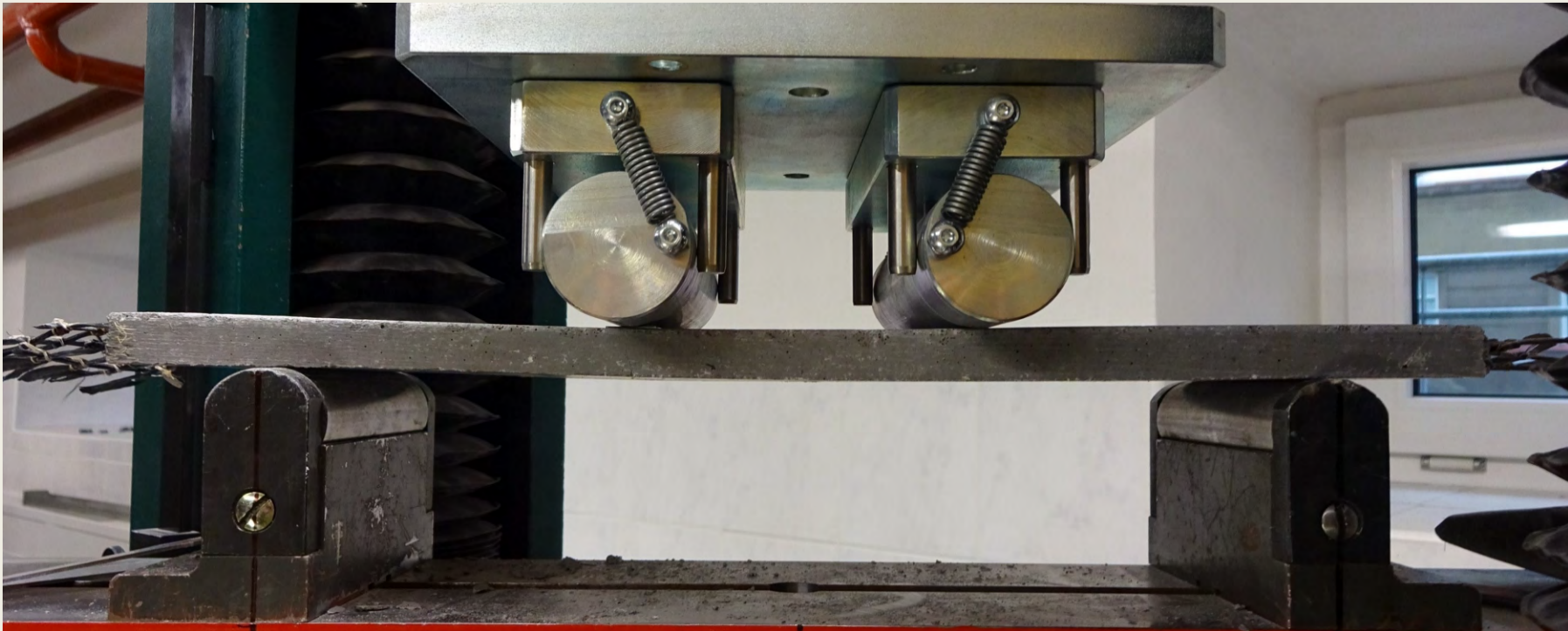
Layout of carbon fiber meshes: Change the layout position and 1 – 3 layers were reinforced in specimens.



Four-point Flexural Test

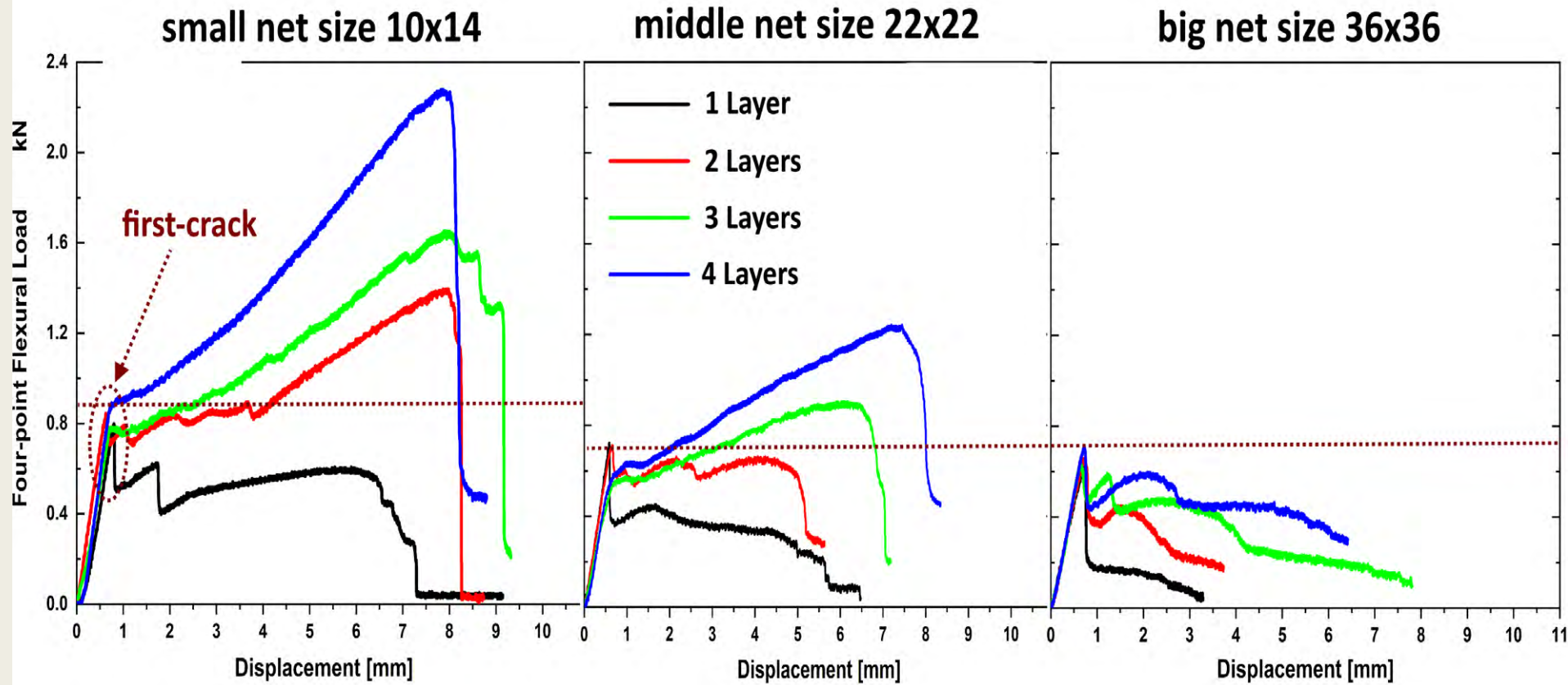


Applied load at loading rate of 4 mm/min.

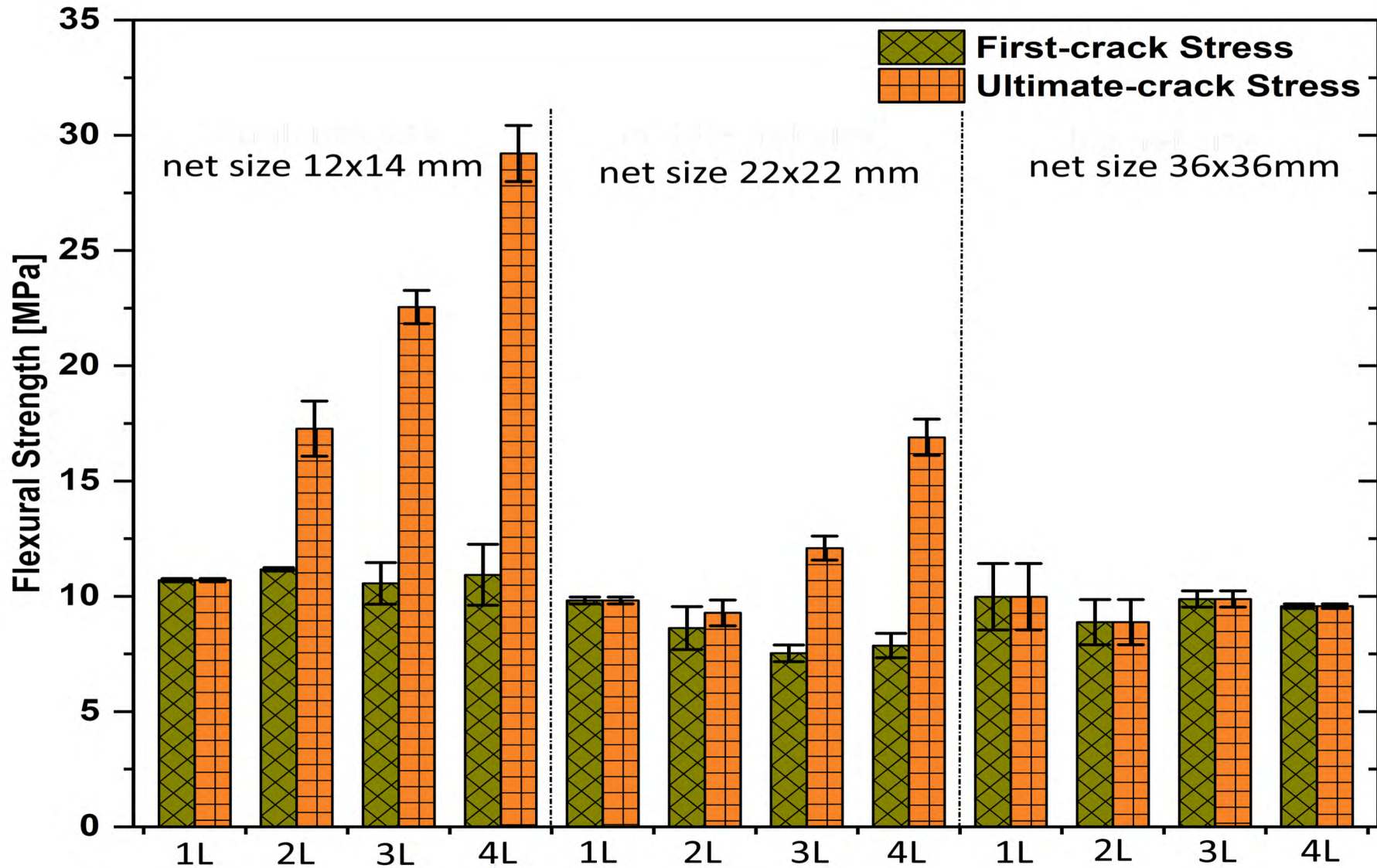


Three samples from each mixture were tested and average value was chosen.

Results - Flexural load – displacement curves of **basalt fiber mesh** geopolymer composite.



Average mechanical strength of basalt mesh geopolymer composite.

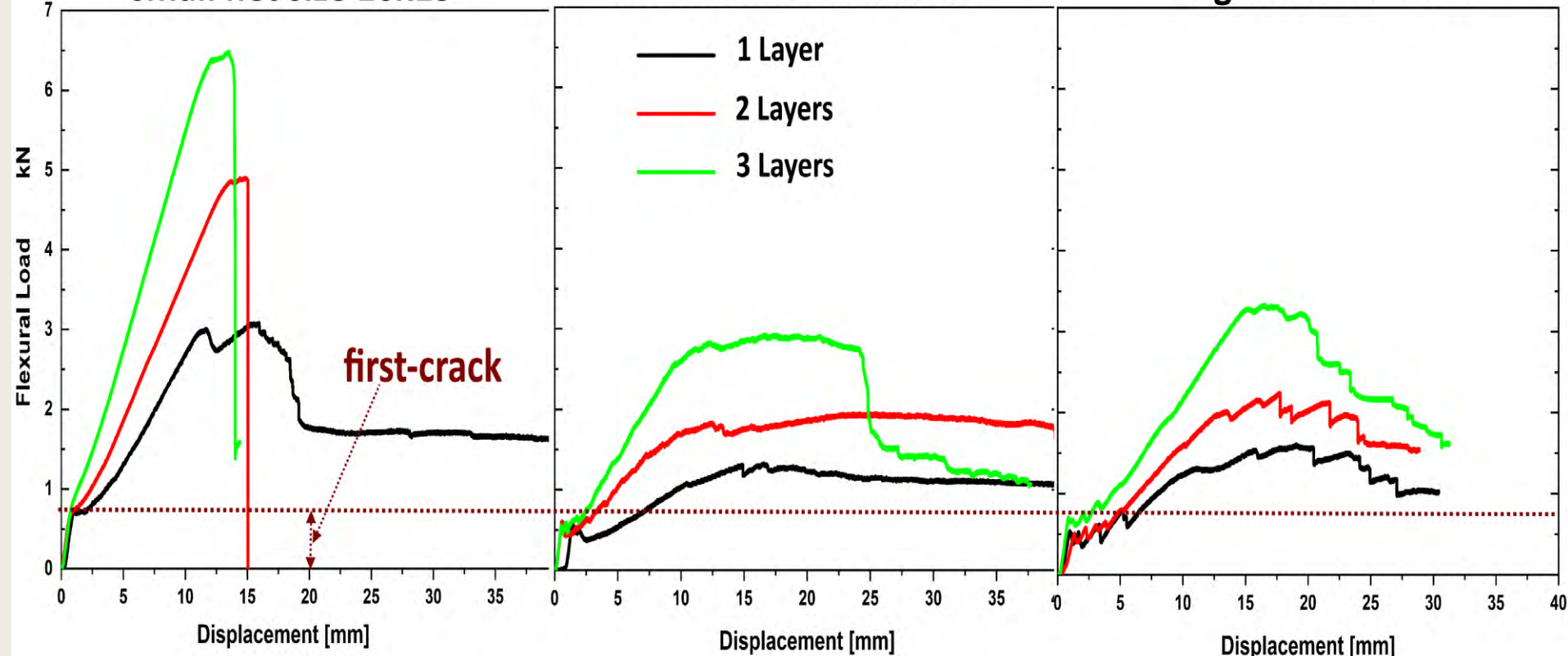


Flexural load – displacement curves of **carbon fiber mesh** geopolymer composite.

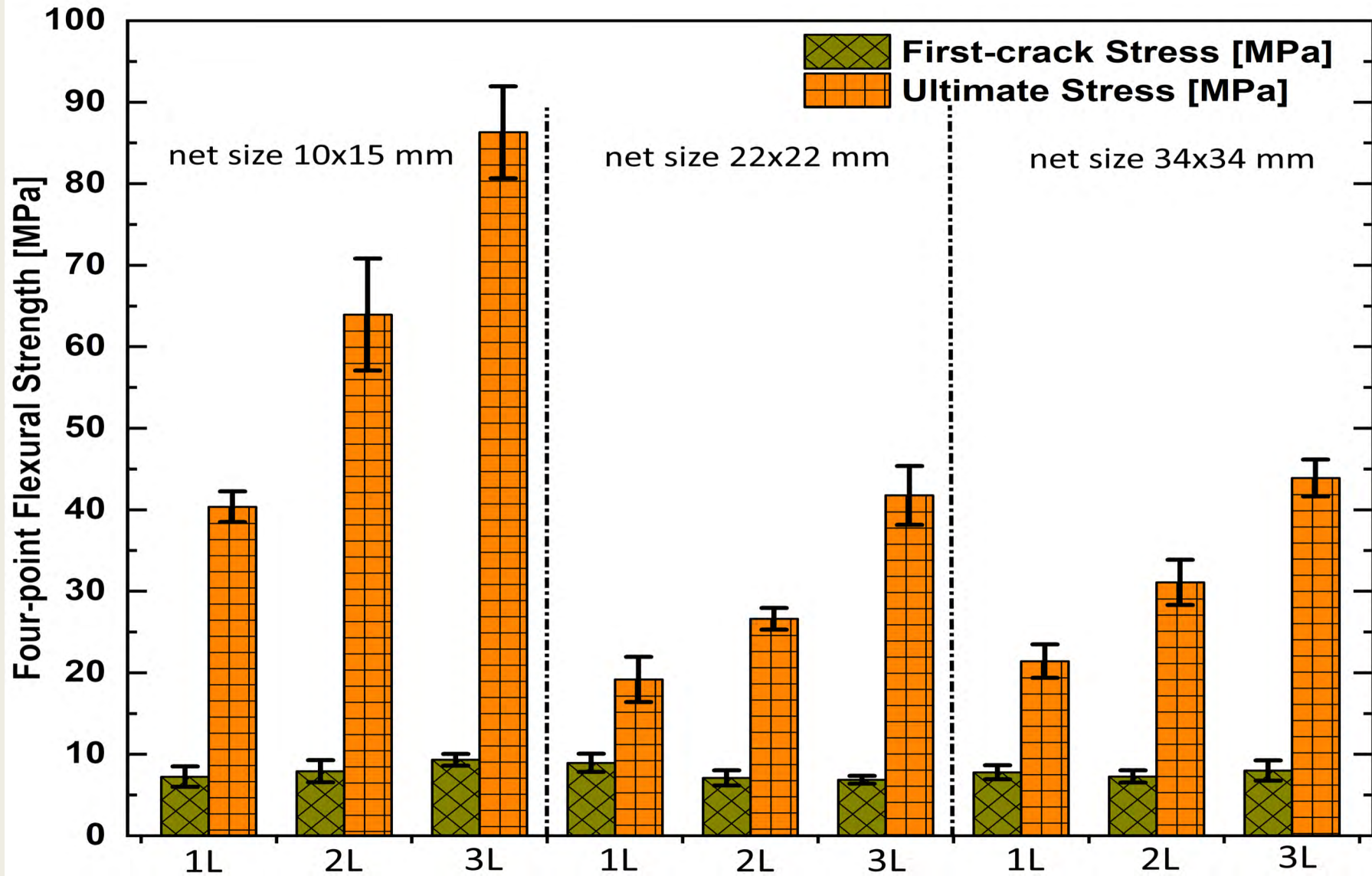
small net size 10x15

middle net size 22x22

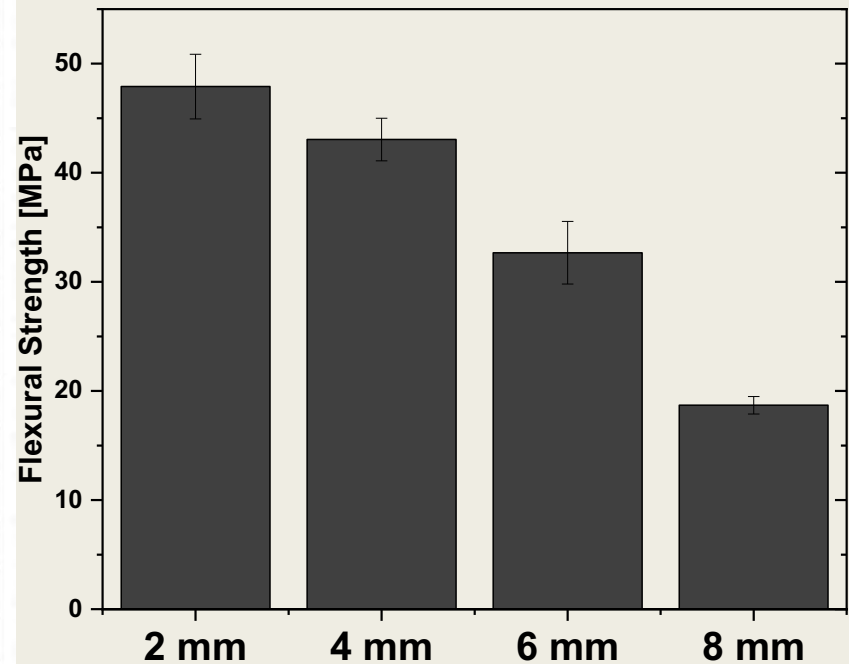
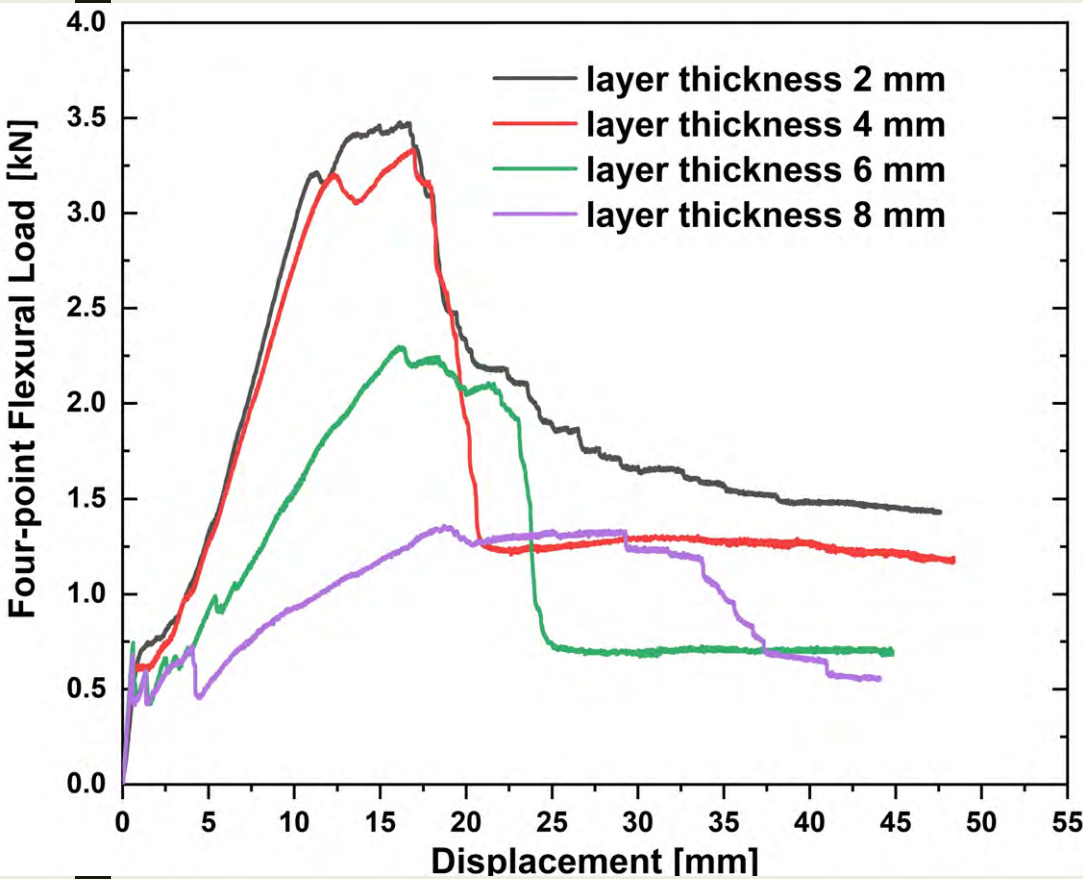
big net size 34x34



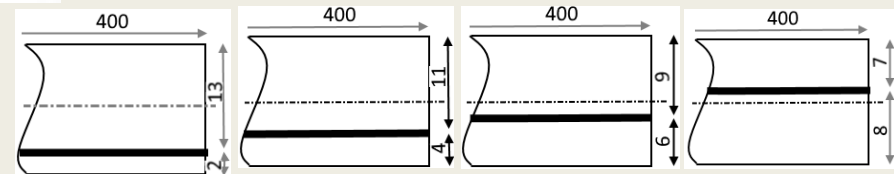
Average mechanical strength of **carbon mesh** reinforced geopolymer composite.



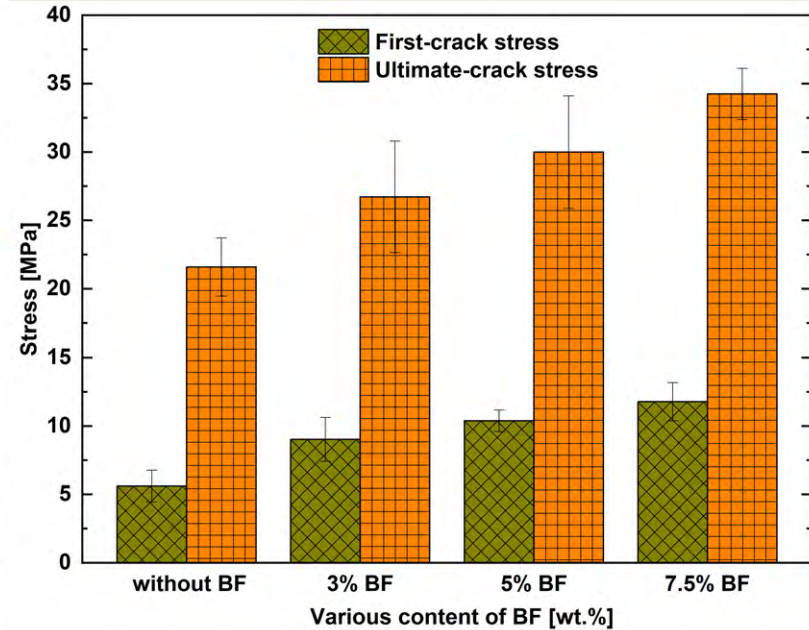
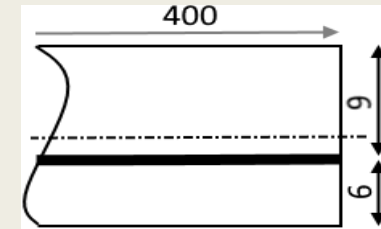
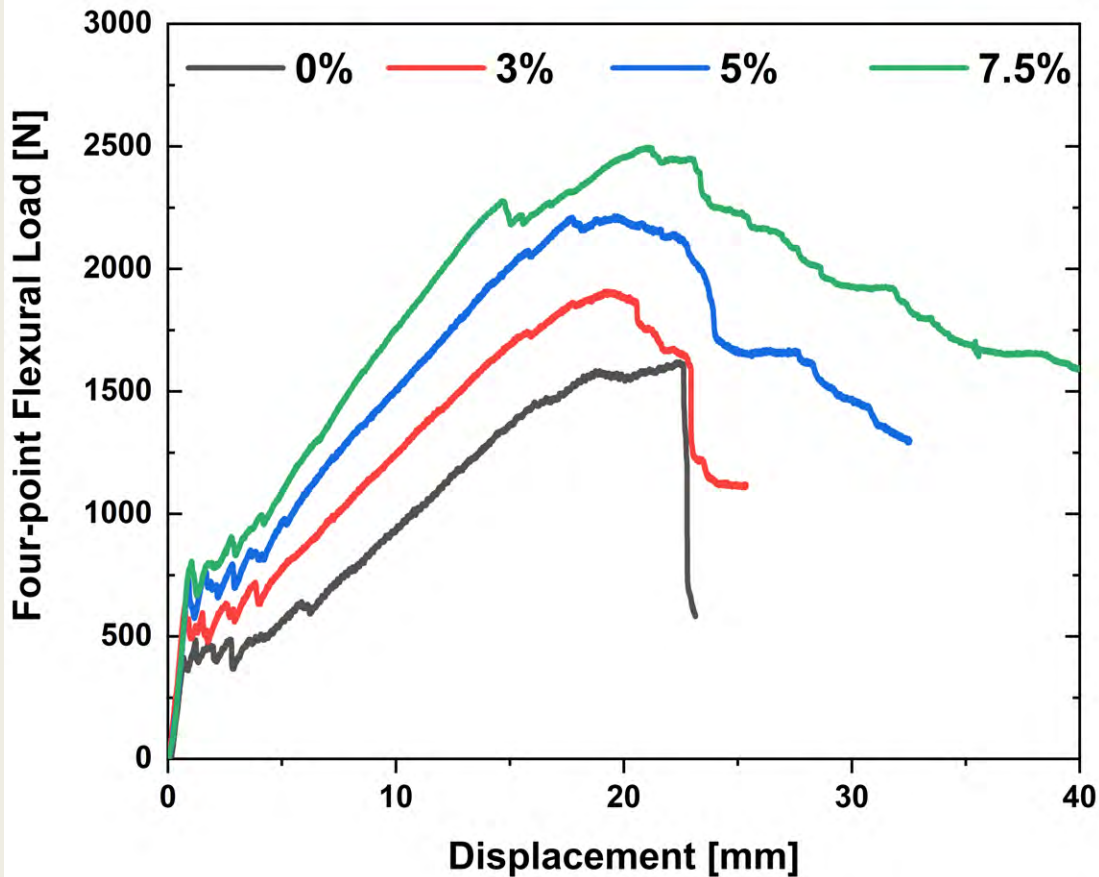
Effect of the layout position of textile layer in the specimens.



Carbon mesh of 10x15 mm



The effect of chopped basalt fiber on the mechanical strength



Carbon mesh of 10x15 mm

Conclusions

1. Using fiber mesh with **small net size** and **multi-layer** **improved significantly** mechanical strength of the composite.
2. No impact on mechanical strength when using basalt fiber **mesh with big net size**.
3. Specimens reinforced with **1-carbon layer (41 MPa)** have achieved flexural strength higher than **4-basalt layer (29.72 MPa)** reinforced specimens.
4. Adding of **chopped basalt fiber** improved the mechanical strength of geopolymer mortar leading to enhanced flexural strength of composite.

THANK YOU FOR YOUR ATTENTION!

