II INTERNATIONAL CONFERENCE
KRASNOYARSK, RUSSIA - 2021

CAMSTECH
International Conference on Advances in Material Science and Technology

Science and Technology City Hall
KRASNOYARSK, RUSSIA

II International Conference on Advances in Materials Science and Technology - CAMSTech-II-2021»

STUDY OF THE EFFECT OF PROPERTIES AND TYPE OF FABRIC ON MECHANICAL PROPERTIES OF COMPOSITE MATERIAL

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Problem statement

- The purpose of the present paper is to study the impact of yarn number, aerial density, reinforcement ratio, and type of fabric construction on mechanical properties of a composite.

Solution methods

- **Materials and methods.**
- **1. Specification of test samples:**
- A composite under study consists of the following components:
- 1. A binder - polyester resin.
- 2. A base - polypropylene, used to form a fabric material
- of two types:
- - woven fabric 1/1;
- - knitted fabric (homogeneous)
- 3. A hardener.
- 4. A catalyst (cobalt)

The tester and samples before and after the test for: a) tensile, b) shear, c) bending, and

d) penetration

Results of tests for tensile, bending, shear, and penetration for composite samples with different bases and different yarn numbers

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	Yarn number, den			
	800	1200	1600	2400
Composite material supported by woven fabric	Results for tensile, N/mm^2			
	124.8	137.6	134.4	124.8
	Results for bending, N/mm^2			
	119.6	132.8	141.1	133.3
	Results for shear, N/mm^2			
	707	732.7	788.9	756.5
	Results for penetration, N/mm^2			
	333.3	360	393.1	365
Composite material supported by knitted fabric	Results for tensile, N/mm^2			
	149.5	161.1	166.4	157.7
	Results for bending, N/mm2			
	152.9	166.6	178.5	180
	Results for shear, N/mm^2			
	699.4	752.9	802.4	777.2
	Results for penetration, N/mm^2			
	344	372.2	393.2	380.3

Results of tests for tensile, bending, shear, and penetration for composite samples with different bases and aerial density

Composite material supported by woven fabric	Aerial density, g/m^2			
	350	325	700	875
	Results for tensile, N/mm^2			
	85.5	112.3	146.9	133.2
	Results for bending, N/mm2			
	111.7	132.2	141.1	144.4
	Results for shear, N/mm^2			
	488.6	676.2	788.9	750.6
	Results for penetration, N/mm^2			
	203.5	352.2	393.2	400.4
Composite material supported by knitted fabric	Results for tensile, N/mm^2			
	124.6	155.5	172.1	170
	Results for bending, N/mm2			
	132.7	165.5	178.5	175.3
	Results for shear, N/mm^2			
	510	733.2	802.4	811
	Results for penetration, N/mm^2			
	199.4	333.2	375	388.1

Results of tests for tensile, bending, shear, and penetration for composite samples with different bases and reinforcement ratio

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	Reinforcement ratio, U_R%			
	20	25	33.33	50
	Results for tensile, N/mm^2			
	75.3	112.9	146.9	140.4
	Results for bending, N/mm2			
Composite material supported by woven fabric	52	90	141.1	144.4
	Results for shear, N/mm^2			
	255.3	456.6	788.9	733.2
	Results for penetration, N/mm^2			
	155.5	239.5	393.2	409.1
	Results for tensile, N/mm^2			
	70.3	114.2	172.1	164.4
	Results for bending, N/mm2			
	50.7	88.9	178.5	165
Composite material supported by knitted fabric	Results for shear, N/mm^2			
	245.9	450	802.4	800
	Results for penetration, N/mm^2			
	152.4	240.3	388.1	369.6

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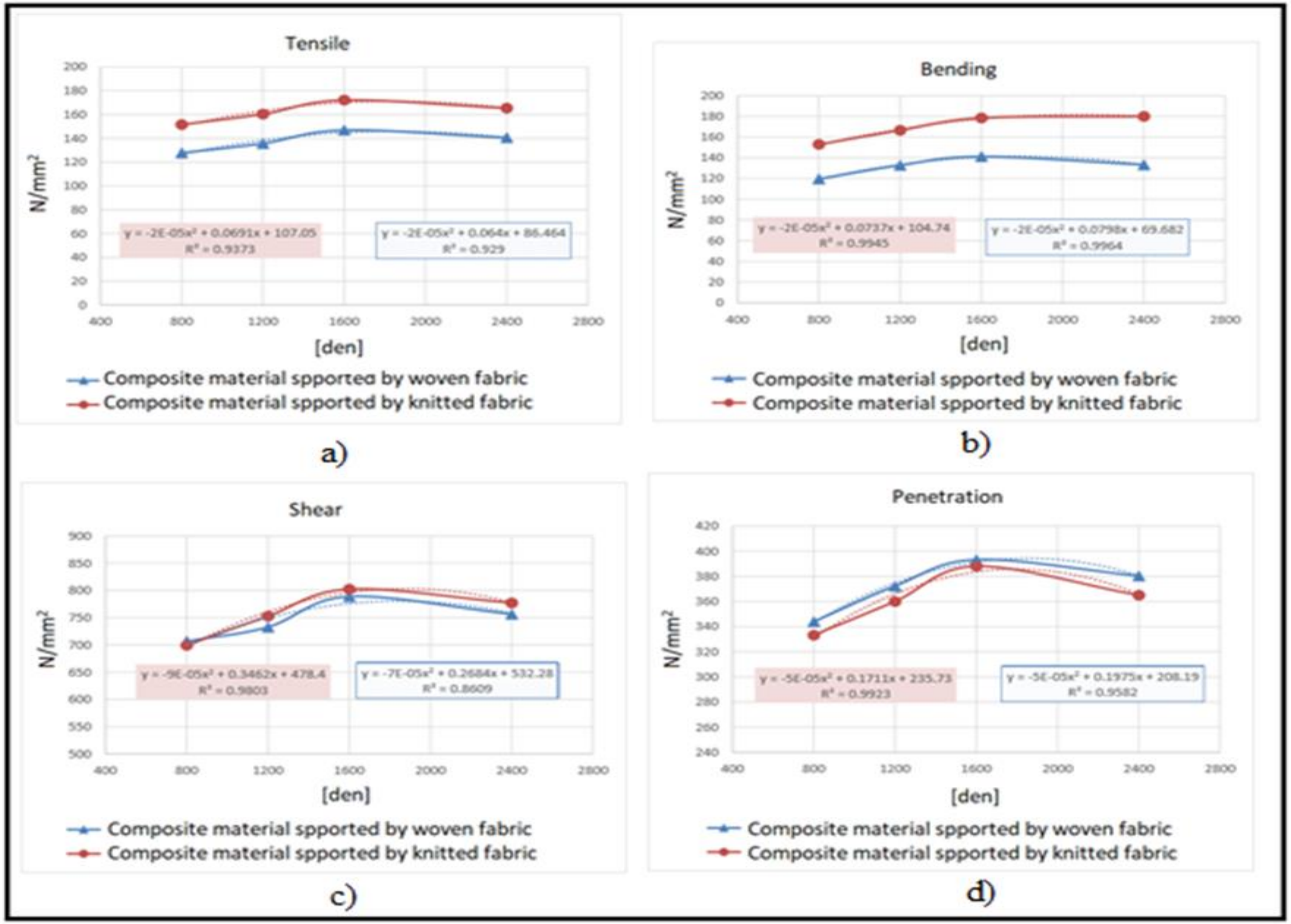

The influence of yarn number on: a) tensile, b) bending, c) shear, and d) penetration of composites

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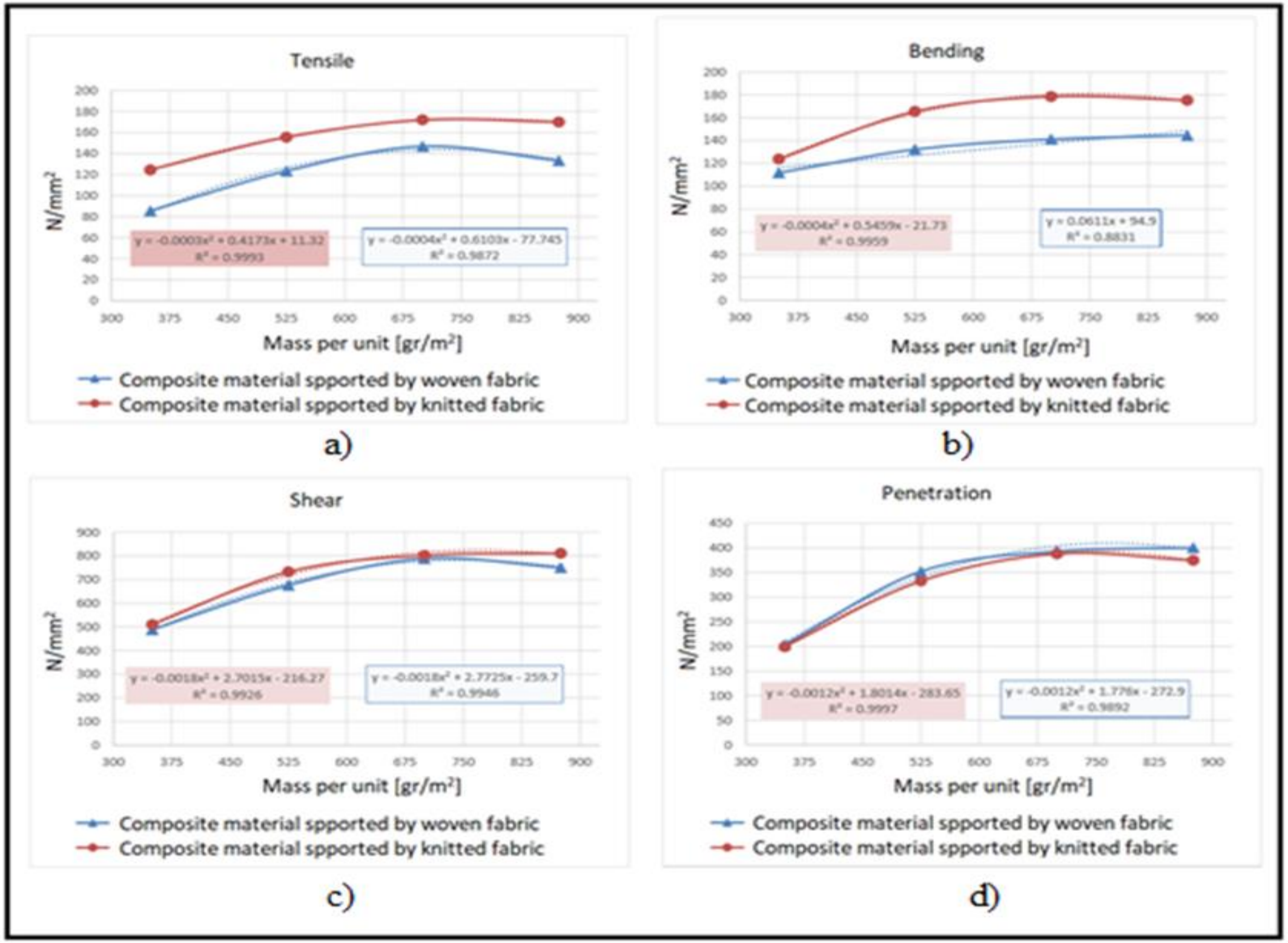

The influence of an aerial density value on composites' strength under:

a) tensile,

b) bending,

c) shear, and

d) penetration

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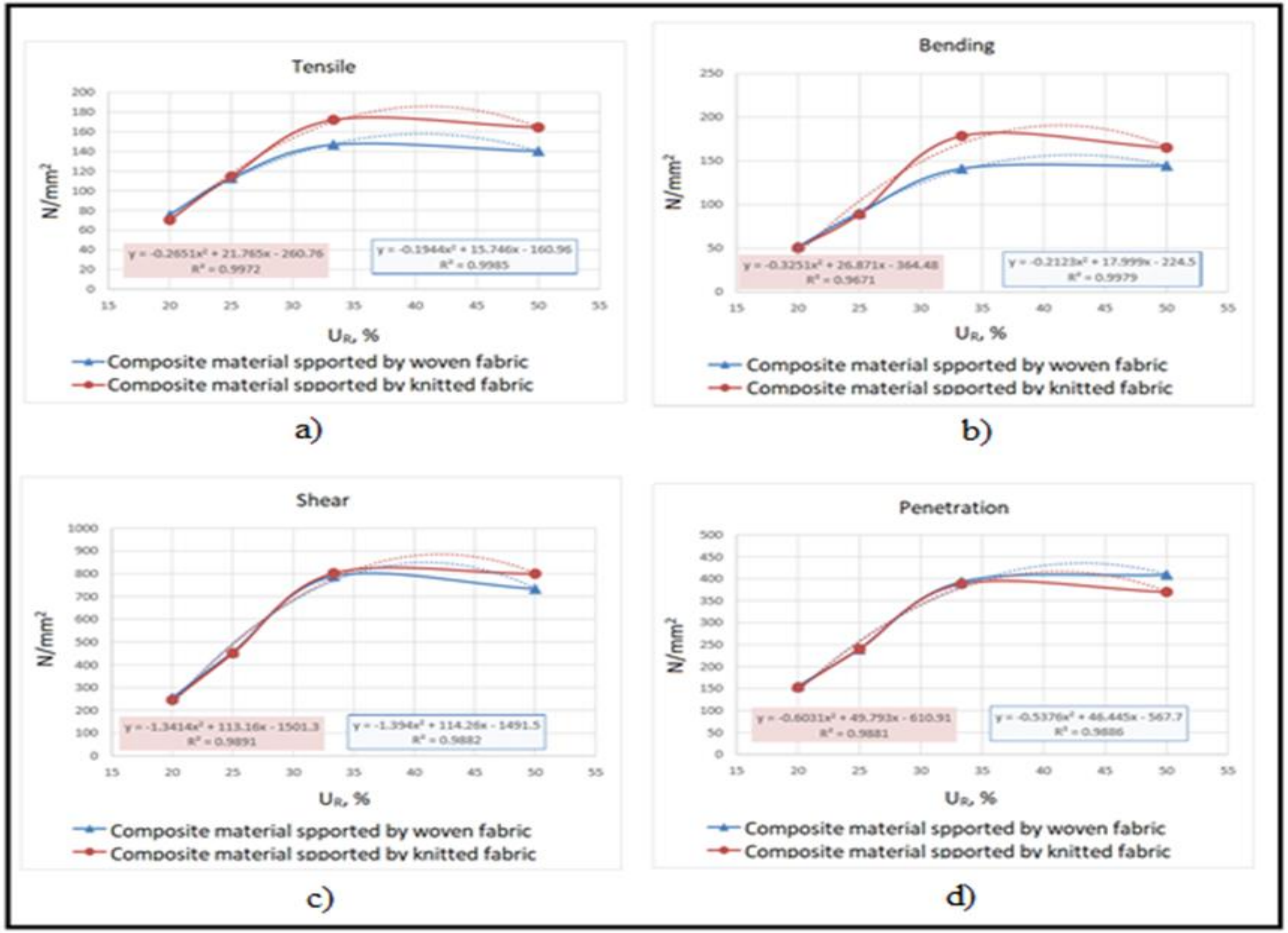

The influence of the reinforcement ratio on: a) tensile,
b) bending,
c) shear, and
d) penetration of composites

Applying the statistical decisions program and multiple regression technique to enter the assumed mathematics (1), (2), and (3), which express the value of every preceding resistance and with a knowledge of yarn numbers, the value of aerial density and reinforcement ratio, we obtain a mathematical model, which is necessary to calculate values of mechanical properties of the corresponding number of yarns, aerial density, and reinforcement ratio required for composites:

$$C = (\alpha_1 \times S_T) + (\beta_1 \times S_B) + \left(\xi_1 \times S_{S_h}\right) + (\eta_1 \times S_P) + \lambda_1 \ldots ; \qquad (1)$$

$$M = (\alpha_2 \times S_T) + (\beta_2 \times S_B) + \left(\xi_2 \times S_{S_h}\right) + (\eta_2 \times S_P) + \lambda_2 \ldots ; \qquad (2)$$

$$U_R = (\alpha_3 \times S_T) + (\beta_3 \times S_B) + \left(\xi_3 \times S_{S_h}\right) + (\eta_3 \times S_P) + \lambda_3 \ldots \qquad (3)$$

Conclusions

- Analysis of the curves in Figure 6a) shows an increase in deformation values the samples after they were supported by fabric materials.The reason is the presence of air bubbles when only a binder is used. It resulted in the stress concentration followed by the brittleness of the material. But a fabric base provides for initial crackles, occurring due to the destruction process, to stop ant it provides additional plasticity of the material.
- As far as the destroying force during tests for tensile is concerned, it was found that the composite supported by knitted fabric has a higher ultimate tensile strength than the one supported by woven fabric due to its void-filling capacity. Moreover, tests were performed perpendicularly to longitudinal yarns of knitted fabric with an increase in the strength of 100% for woven fabric and of 233.33% for knitted fabric.
- Analysis of the curves in Figure 6b) shows that the ultimate bending strength of the composite supported by knitted fabric with a binder turned out to be higher than of that supported by woven fabric, as the material supported by woven fabric has less elasticity that the material supported by knitted fabric, which resulted in higher brittleness and destruction of the material supported by woven fabric under a lower value of stresses. It was found that the percent of a rise in bending strength for the material supported by woven fabric was 233.33%, and for the material supported by knitted fabric - 325.53%

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