Строительные материалы и изделия

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IMPROVEMENT OF THE EXPANSIVE QUALITY OF GROUND (CONCENTRATING, CONSOLIDATION, CBR, DIAMETRICAL FORCE) WITH THE HELP OF WARP KNITTED STRUCTURE

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According to technical and economic characteristics it’s possible to replicate geosynthetics in house building and road repairing. Geosynthetic layers strengthen slopes and protect them from erosion; geosynthetic layers improve grass plot, minimize ground deformation and many other scientific works about the road and house building we come to the conclusion that it’s necessary to develop such materials as geosynthetics with warp knitted structure.

Some experimental research in special laboratories for every case to test synthetic fiber for climatic and mechanical influences had been done.

Geotextiles with warp knitted structure were tested for strengthening, compressibility, elasticity. The materials are tested for tear-stability. Stability is tested by the method of cylindrical cliche which helps to value stability of joints, press-and-hit-stability. Temperature, ultraviolet, acid and alkaloid influences test fiber in its chemical and physical qualities. All experiments done led to, that vc geotextiles with warp knitted structure can be applied to improving expansive ground qualities (concentrating, consolidating, CBR, diametrical force) because they have all necessary qualities required to such materials.

Keywords: knitted structure, expansive quality of ground, geotextile.

Application experience

Warp knitted structure is a part of varied road building materials because it has good characteristics: it’s flexible, can be used at different temperatures outdoors, it doesn’t depend on environment’s changers such as rain, snow and its application is very easy. The examples of warp knitted structure application are armature pivots and armature frameworks in monolithic constructions. They have got the same characteristics as the hot-made armature. But warp knitted structure is lighter than the hot-made armature and its installation are very easy [1, p. 69].

The VII International Conference 2007 in Nyssa gave the information that the production of warp knitted structures and geosynthetics has reached around the world about 1.2–1.5 milliard m^2. The Northern America and Europe produce at 300 million m^2 each, 80 % of Europe production volume are not weaved linen and the manufactured articles with warp knitted structures in them.

In general the application experience of geotextile materials with warp knitted structures isn’t wide spread in Asia and in the middle east our country. This fact has objective and subjective causes:

- Manufacturing market is very small. The European production of geotextile materials with warp knitted structures is represented badly on our market. That’s why we haven’t enough information about warp knitted structure, about its quality technical peculiarities and about its production technology.
- The main reason of application geotextile materials with warp knitted structures is that the ground swelling around the building foundation is less and its deformation is smaller. This is actually for house and road building. But our builders don’t show interest to new technologies because they don’t have prolonged obligations for houses and roads they’ve built.
- All facts mentioned before prevent from the wide application of geotextile materials with warp knitted structure. Table 1 shows the most important qualities of synthetic fiber [2].

In Russia (which is considered as a greatest country) for example, they have only one producer of warp knitted structure. Its Steklo-Progress Company GmbH. The fiber mark quality “Armdor” is comparable with “HUESKER *Synthetic* GmbH&Co”. The company products geo-nets from NMBAF-threads' mark “HaTelit”. The characteristic you can see in Table 2.

Processing of the results of measurements of maximum load is performed as follows, except for those materials, which include the geogrid and geogrid: material tensile strength of the samples T N / m. It is calculated for each sample according to the formula:

$$T = \frac{F_{\max}}{B}$$

where $F_{\max}$ – maximum load at break of the sample, N;
B – specimen width, m.

Table 1

Main properties of synthetic fibers

Index	Synthetic fibers		
	Polyether	Polyamide	Polypropylene
Waterproof	Good	Lowering of strength by 30 % in moisture	Good
Decay proof	Good	Good	Good
Stability against acid and alkali, which can concentrate in real exploitation	Lowering of strength in alkali condition with pH²9		
Lightproof	Good	Bad	Bad
Mechanical fiberProperties	Good	Good	Low length stability

Table 2

Physical and mechanical qualities of geo-nets made from NMBAF fiber with warp knitted structure

Index	Geo-nets made from NMBAF fiber				Geo-nets from warp knitted structure		
	Hatelit C 40/17	Hatelit C 40/17	Hatelit 30/19	Hatelit C30/13	ГСК 50	ГСК70	ГСК200
Specific density(g/m²)	330	240	460	240	320	450	700
Cell size (mm)	40×40		30×30	30×30	25×30	25×30	25×30
The most stability by strengthening, longitudinal/ diametrical(kN/m)	50/50		90/90	50/50	50/50	70/70	200/200
Lengthening by gap,% longitudinal/ diametrical	12/12	12/14	12/14	12/14	4/4	4/4	4/4

– Tensile strength of the material $T_{\max}$, N/m, calculated separately for each direction tests (separately for each group of samples) according to the formula:

$$T_{\max}^{i} = \sum_{i=1}^{n}\left(\frac{T_i}{n}\right)$$

where T_i – tensile strength of the material at the *I*-sample, tested in tension in this direction with a positive result, N/m;

n – the total number of specimens tested in the tensile direction with a positive result;

Calculation result is converted into kN/m and rounded to two significant figures;

– Average coefficient of variation C_p,%, determined by the formula [3, p. 77]:

$$\mathrm{C_p} = \frac{\sigma}{T_{\max}}100\%$$

Where σ_p – standard deviation, which is calculated according to the formula:

$$\sigma_p = \sqrt{\frac{\sum_{i=1}^{n}(TR_{\max} - T_i)}{n}}\ .$$

The coefficient is isotropic strength K_i, the ratio of the strength in the longitudinal T_l strength to transverse direction T_{tr}, calculated by the formula:

$$K_i = \frac{T_l}{T_{tr}}$$

where T_l – strength of the material $T_{\max}$ in the longitudinal direction, kN/m; T_{tr} – strength of the material $T_{\max}$ in the transverse direction, kN/m.

Processing of the results of measurements of maximum load obtained during testing samples of materials which include geogrid, is performed as follows:

– The results of measurement of maximum load shall be rounded to three significant digits;

– Material strength tensile samples T, N/m, calculated for each sample according to the formula:

$$T = \frac{F_{\max}}{N_r}N_t\ ,$$

Where $F_{\max}$ – the maximum load at break of the sample, N;

N_r – number of elements (ribs) in the cross section of the sample;

N_t – the number of elements (ribs) per unit width of the material.

The value obtained is converted in kN/m and rounded off to two significant figures.

Geonets of Russian production are twice cheaper as compared with foreign producers. But the maximal breadth of bobbin fiber is 3m what is negative [4].

The most negative quality of warp knitted structure is its bad elasticity which is 2–4 %. That's why the material can't be used in moveable and waterlogged soils.

Geotextiles with warp knitted structure don't flame, they are decaying proof, very strong, they keep warm and have sound isolating qualities. The fiber is stable against gap because of the deformation external fiber layer to the inside layer. It is lineal dependence between deformation and mechanical force (pressure) [5, p. 45] (Fig. 1).

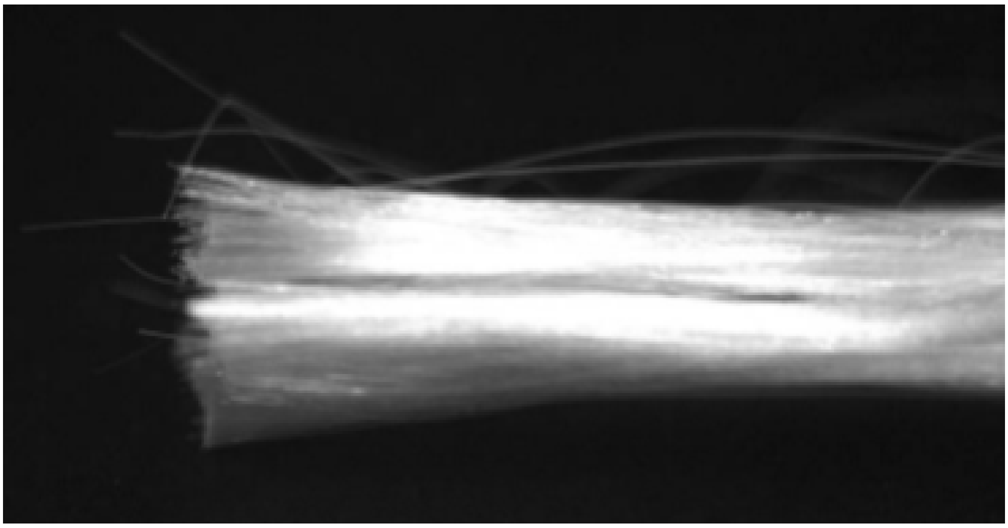

Fig. 1. Glass rovings

2. Scientific research and its results

To make sure that the material can be used in this or that ground (to make better qualities of ground such as concentrating, consolidating), we must do experimental research in special laboratories for every case to test synthetic fiber for climatic and mechanical influences.

Geotextiles with warp knitted structure are tested for strengthening, compressibility, elasticity. The materials are tested for tear-stability. Stability is tested by the method of cylindrical cliche which helps to value stability of joints, press-and-hit-stability [6, p. 53].

Temperature, ultraviolet, acid and alkaloid influences test fiber in its chemical and physical qualities.

Range experiment is the most expensive. Its results are the best as they are the most realistic and true life. Such experiments reflects the life situation with the concrete object. The experimental block should be done on the road hollow then we add sand road metal; all the structure should be pressed with road machine. After the test the experimental block is to be tested, visual for damages and elasticity property. The temperature and atmosphere influences are tested in the open air for some time and all damages are described.

Geotextile fiber with warp knitted structure is tested in range experiment and all results are compared with analogous fiber [7].

In scientific work are used to vary the structure and raw material fibers. Its results we show in the Tables 3, 4.

The models were tested 24 hours in relative air humidity 65 % (±2%) t = 20 ºC(±2º). In histogram in Fig. 2 we show the analyses of stability in diametrical and longitudinal sections.

Our research work presents various characteristics in longitudinal and diametrical sections. These

Table 3

Parameters ultimate strength (gap)

Model	Raw-material	Specific density, g/m^2	Highest stability against gap kN/m							
			Longitudinal					Diametrical		
Weaved geonet GR-GT-TC 40*40	PET	350				Mean value				Mean value
			86.4	92	83.8	87.4	48.8	46.6	48.3	47.9
Knitted geonet with layer GR-GT-VZ 35*35	PET	250	76.1	84.7	79.2	80	127.7	126	127.3	127
Geonet GR-GP-E 40*40	PP	530	39.7	39.3	39.5	39.5	39.25	39.3	39.8	39.45
Knitted geonet with layer GR-GT-VZ 20*20	PET	200	22.7	23.5	22.8	23	27.4	24.2	24.9	25.5
Knitted geonet GR-GT-VZ 35*35	PET	300	41.3	43	42	42.1	49.6	48	48.5	48.7
Knitted geonet GR-GT-VZ 40*40	Warp knitted structure	285	49.6	49	49.6	49.4	46.2	46	46.4	46.2

Table 4

The parameters of relative lengthening by gap

Model	Raw-material	Specific density, g/m²	Relative lengthening by gap							
			Longitudinal				Diametrical			
						Mean value				Mean value
Weaved geonet GR-GT-TK 40*40	PET	350	16.7	15.5	15.8	16.0	11.6	12.3	12.1	12.0
Knitted geonet with layer GR-GT-VZ35*35	PET	250	13.8	13.7	14.5	14.0	16.2	15.9	15.9	16.0
Geonet GR-GP-E 40*40	PP	530	12.2	12.0	12.1	12.2	12.0	12.0	11.4	11.8
Knitted geonet with layer GR-GT-VZ20*20	PET	200	28.3	27.8	27.9	28.0	29.5	29.8	30.7	30.0
Knitted geonet GR-GT-VZ35*35	PET	300	8.9	8.9	9.2	9.0	11.5	10.5	11.0	11.0
Knitted geonet GR-GT-VZ40*40	Warp knitted structure	285	2.1	2.5	2.6	2.4	2.4	2.82	2.7	2.64

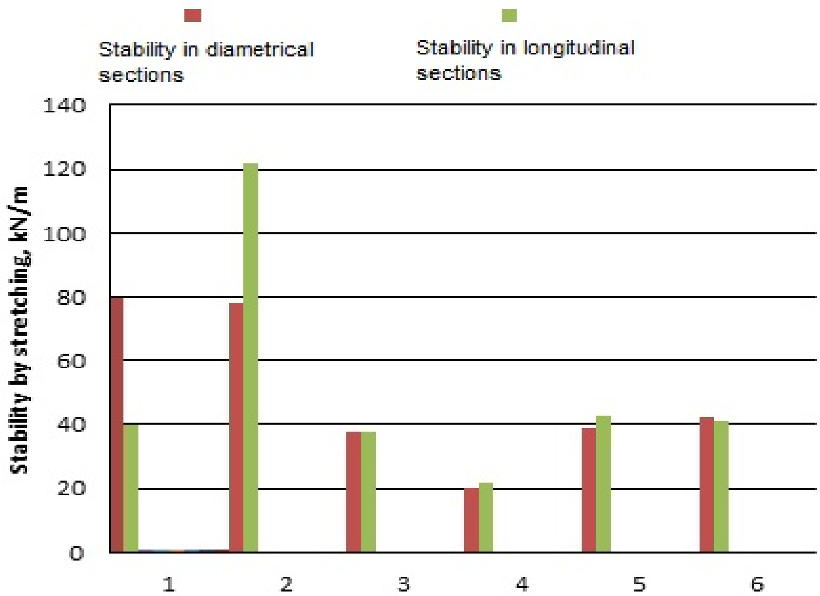

Fig. 2. Histogram of tensile strength

results are exceeded using the displacement of specific density in giving directions. All results are presented in histogram in Fig. 3 [8].

The research work proves that geotextiles with warp knitted structure is resistant enough against exerting pressure. As the result the relative lengthening has given parameter 2.4–2.64 %. But the difference between the researched models isn't big.

All researched models were put to the test for resistance with the help of breaking machine MP/ 20 in the laboratory. The results are given in Table 5 and histogram in Fig. 4 [9, p. 78].

Improvement

Taking into consideration range and laboratory experiments we come to the conclusion that mechanical properties depend directly on cell's dimensions and on production technology.

Application characteristics (precipitation, ultraviolet) of fiber with warp knitted structure have the best parameters in our research work. But there are some negative properties such as resistance, reduce against chemical influence. We don't know exactly why. We think that not all fiber models could be tested because of its quality.

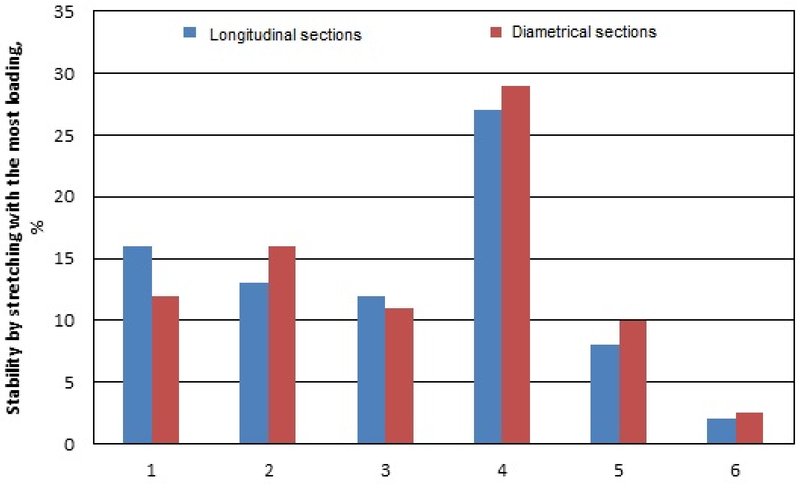

Fig. 3. Histogram elongation at a load in two directions

Table 5

Models' parameters in mechanical test

Model	Stability by strengthening, kN/m								Keeping of stability as compared with model	
	Longitudinal				Diametrical				long	diam.
				Mean value				Mean value		
Weaved geonet GR-GT-TK 40*40	77.14	74.6	81.6	77.78	42.8	45.73	48.0	45.51	89	95
Knitted geonet with layer GR-GT-VZ35*35	75.0	69.5	71.5	72.0	109.4	120.5	116.9	115.6	90	91
Geonet GR-GT-E 40*40	40.7	39.1	38.7	39.5	39.8	40.4	38.3	39.5	100	100
Knitted geonet with layer GR-GT-VZ20*20	22.2	22.9	23.9	23.0	18.3	17.8	17.3	17.8	100	70
Knitted geonet GR-GT-VZ35*35	33.3	30.9	30.6	31.6	46.3	49.9	49.9	48.7	75	100
Knitted geonet GR-GT-VZ 40*40	39.5	41.5	41.1	40.7	44.2	46.6	45.1	45.3	88	98

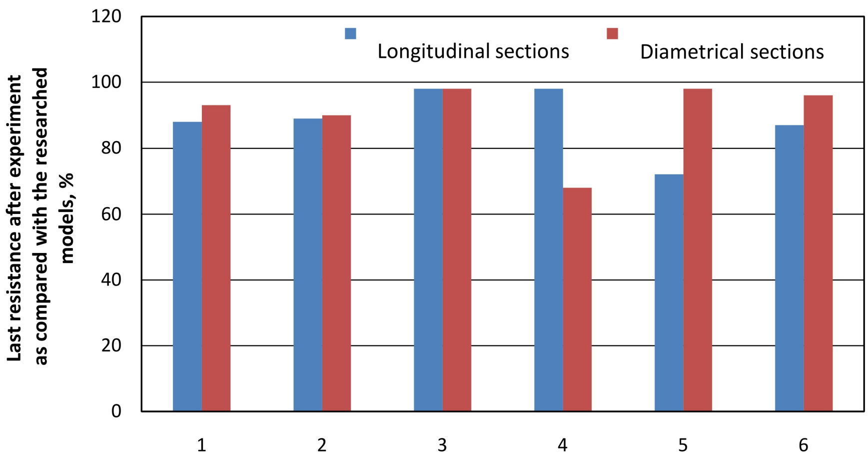

Fig. 4. Histogram shows the least resistance after the experiment

In order to improve the certainty fiber parameters we need to pick them out and improve the technological manufacturing process. We need also to choose the best fiber models to become the most precise results.

During the research work we've come to the conclusion that the range experiments are more effective than in laboratories because textiles become more damages on the range than in the laboratory with the same loading.

The mechanical qualities of geotextiles with warp knitted structure depend more on production profile and on hold on production technology; the other important condition is dimension of cells (cells' size).

Climatic influences on research material were also successful. They've demonstrated that warp knitted structure can be used in different weather not to pay attention to natural weather changes, and ultraviolet-rays are very small and they don't exert influence on material.

All experiments have led to, that geotextiles with warp knitted structure can be applied to improving expansive ground qualities (concentrating, consolidating, CBR, diametrical force) because they have all necessary qualities required to such materials.

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УСОВЕРШЕНСТВОВАНИЕ СВОЙСТВ ГРУНТА ПРИ ПОПЕРЕЧНОМ РАСШИРЕНИИ (КОНЦЕНТРАЦИИ, КОНСОЛИДАЦИИ, КАЛИФОРНИЙСКОГО ПОКАЗАТЕЛЯ ПРОЧНОСТИ (CBR), ДИАМЕТРАЛЬНЫХ УСИЛИЙ) С ПОМОЩЬЮ МАТЕРИАЛОВ НА ПЛЕТЕНОЙ ТКАНЕВОЙ ОСНОВЕ

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В соответствии с технико-экономическими характеристиками геосинтетические материалы можно использовать во время строительства жилых зданий и проведения ремонтных работ. Геосинтетические слои укрепляют откосы и защищают их от эрозии. Они также укрепляют обочины дорог, засеянные травосмесью, и значительно уменьшают деформации. Изучение множества научных трудов по дорожному и гражданскому строительству позволило прийти к выводу о необходимости разрабатывания геосинтетических материалов на плетеной тканевой основе.

В каждом отдельном случае были проведены экспериментальные исследования в специальных лабораториях для определения воздействия климатических и механических факторов на синтетическое волокно.

Геотекстиль на плетеной тканевой основе испытывали на прочность, сжимаемость и эластичность. Материалы также были испытаны на устойчивость к разрыву. В основе определения прочности лежит метод цилиндрического клише, который позволяет определить прочность соединений на сжатие и при ударе. Под воздействием температуры, ультрафиолета, кислоты и алкалоидов изучают химические и физические свойства волокна. На основе результатов экспериментов сделан вывод, что геотекстильный материал на плетеной тканевой основе может быть применен для улучшения характеристик грунта при поперечных деформациях (концентрации, консолидации, CBR, диаметральных усилий), поскольку обладает необходимыми свойствами, требуемыми для подобных материалов.

Ключевые слова: плетеная тканевая основа, свойства грунта при поперечном расширении, геотекстиль.

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