THE INFLUENCE OF ENVIRONMENT TEMPERATURE VARIATION ON THE STRENGTH CHARACTERISTICS OF COMPOSITE MATERIALS TYPE "ALUCOBOND"

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Abstract: *In this paper the authors present an analysis of the influence of temperature variation on the strength characteristics of the composite material called „ALUCOBOND";, a material used in construction on plating exterior wall of buildings and the execution of ornamental ensembles for advertising purposes.*

Keywords: *composite material, environment, temperature, resistance*

1. General consideration

The composite material called ALUCOBOND is made of aluminum plate of 0.5 mm, joined by a core of permanent polyethylene; blend is achieved at constant chemical and mechanical (hot-rolled and pressure) and the grip is perfect on all the material. This structure provides a surface rigidity of the composite material, resistance to bending, perfect flatness and ease of processing.

Even if they have a lightweight compared to other materials, ALUCOBOND boards have a very good resistance to breaking or bending, while the plates have exceptional qualities in terms of resistance at high pressures and buckling. Polyethylene core which is non-toxic have a good density and improves resistance to fire.

ALUCOBOND dampens vibrations of 9 - 10 times more efficiently than aluminum sheet; he behaved as an electromagnetic coating and for this reason is a very good solution for plating hospitals, airports, military bases, buildings in city centers etc. Also the manufacturers of these composite materials say that ALUCOBOND does not change the mechanical properties between -50 $^{\circ}$C and +80 $^{\circ}$C, [3]

2. Experimental details

Because this composite material is used for external plating of the buildings walls and the execution of ornamental ensembles for advertising purposes which is used as a support for various objects, the authors proposed to determine whether the environmental temperature changes affect its resistance properties.

To do this, lots of 10 pieces of 4 mm thick by ALUCOBOND were subjected to following laboratory thermal stresses:

I. without thermal stresses (samples in delivery state of material);
II. long cycle of heating-cooling;
III. two long cycles of heating-cooling;
IV. three long cycles of heating-cooling;
V. six short cycles of heating-cooling.

A "long cycle" consisted of heating samples in an oven at 37 $^{\circ}$C for one hour followed immediately by cooling to -30 $^{\circ}$C for one hour, cooling done in a laboratory refrigerator existing in thermal treatments at "Stefan cel Mare" University Suceava. The "short cycle", heating and cooling were performed at the same temperature (37 $^{\circ}$C and -30 $^{\circ}$C), but times were held at that temperature were only 15 minutes. The samples were made in accordance with applicable standards (SR EN 10002-1:2002) [2].

After the planned thermal stresses, the samples were traction tested. These tests were conducted in Technology of Cold Pressing laboratory on a traction test machine of steel specimens (Figure 1), it is equipped with a linear displacement transducer which is connected with a strain gauge deck plate by acquisition board LabJack U12 and makes possible the transmission of values to a computer [4]. Using special software, the data transmitted can be automatically calculated and displayed

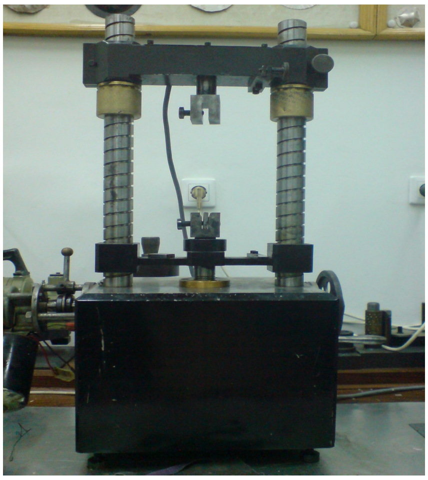


Figure 1. *Traction test machine of steel samples*

Acquisition and evaluation size program is made in LabView programming environment; it takes the sensor information in a chart representation as presented in Figure 2. The application contains a button to save data to a file type. ".dat" The charts of the two sizes are represented in different colors: red - "force" and green - "elongation".

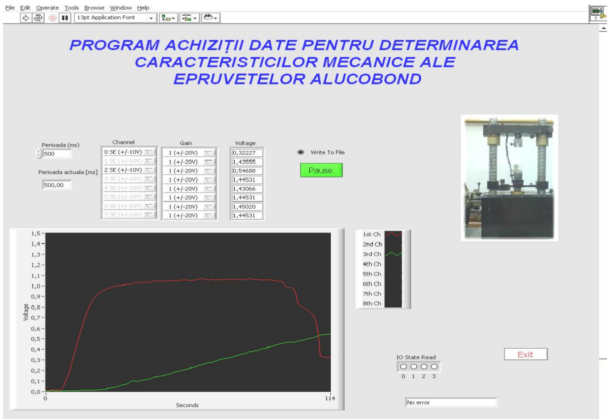
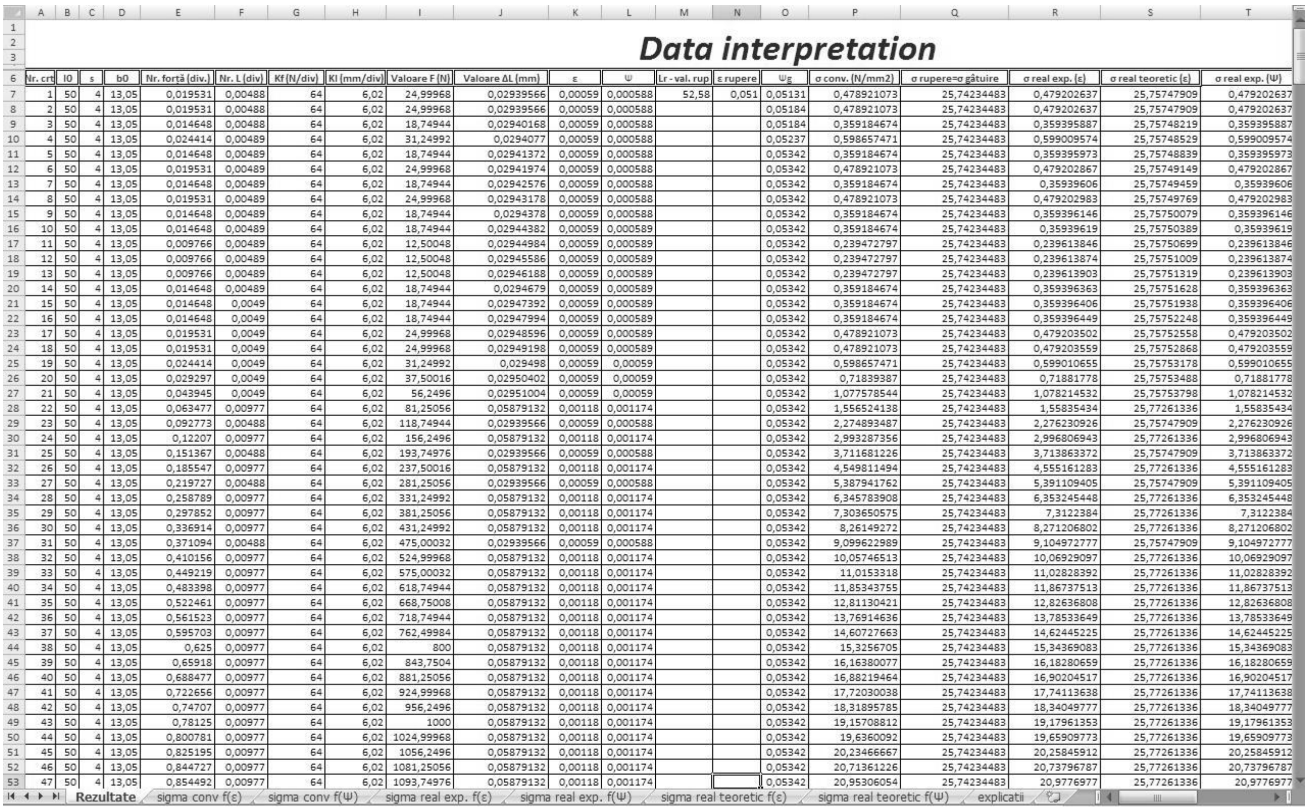


Figure 2. *Chart representation of the sizes results in the traction test*

The values recorded in the file. ".dat" are open with Microsoft Office Excel program (Figure 3) are taken only force and elongation recorded values and placed in another Excel program that can generate the following representations charts: conventionally σ (ε); conventional σ (ψ), real experimental σ (ε), real experimental σ (ψ), real theoretically σ (ε), real theoretically σ (ψ), [1].



Data interpretation

Nr. crt	l0	s	b0	Nr. forță (div.)	Nr. L (div)	Kf (N/div)	Kl (mm/div)	Valoare F (N)	Valoare ΔL (mm)	ε	Ψ	Lr - val. rup	ε rupere	Ψg	σ conv. (N/mm2)	σ rupere=σ gâtuire	σ real exp. (ε)	σ real teoretic (ε)	σ real exp. (Ψ)
1	50	4	13,05	0,019531	0,00488	64	6,02	24,99968	0,02939566	0,00059	0,000588	52,58	0,051	0,05131	0,478921073	25,74234483	0,479202637	25,75747909	0,479202637
2	50	4	13,05	0,019531	0,00488	64	6,02	24,99968	0,02939566	0,00059	0,000588			0,05184	0,478921073	25,74234483	0,479202637	25,75747909	0,479202637
3	50	4	13,05	0,014648	0,00488	64	6,02	18,74944	0,02940168	0,00059	0,000588			0,05184	0,359184674	25,74234483	0,359395887	25,75748219	0,359395887
4	50	4	13,05	0,024414	0,00489	64	6,02	31,24992	0,0294077	0,00059	0,000588			0,05237	0,598657471	25,74234483	0,599009574	25,75748529	0,599009574
5	50	4	13,05	0,014648	0,00489	64	6,02	18,74944	0,02941372	0,00059	0,000588			0,05342	0,359184674	25,74234483	0,359395973	25,75748839	0,359395973
6	50	4	13,05	0,019531	0,00489	64	6,02	24,99968	0,02941974	0,00059	0,000588			0,05342	0,478921073	25,74234483	0,479202867	25,75749149	0,479202867
7	50	4	13,05	0,014648	0,00489	64	6,02	18,74944	0,02942576	0,00059	0,000588			0,05342	0,359184674	25,74234483	0,35939606	25,75749459	0,35939606
8	50	4	13,05	0,019531	0,00489	64	6,02	24,99968	0,02943178	0,00059	0,000588			0,05342	0,478921073	25,74234483	0,479202983	25,75749769	0,479202983
9	50	4	13,05	0,014648	0,00489	64	6,02	18,74944	0,0294378	0,00059	0,000588			0,05342	0,359184674	25,74234483	0,359396146	25,75750079	0,359396146
10	50	4	13,05	0,014648	0,00489	64	6,02	18,74944	0,02944382	0,00059	0,000589			0,05342	0,359184674	25,74234483	0,35939619	25,75750389	0,35939619
11	50	4	13,05	0,009766	0,00489	64	6,02	12,50048	0,02944984	0,00059	0,000589			0,05342	0,239472797	25,74234483	0,239613846	25,75750699	0,239613846
12	50	4	13,05	0,009766	0,00489	64	6,02	12,50048	0,02945586	0,00059	0,000589			0,05342	0,239472797	25,74234483	0,239613874	25,75751009	0,239613874
13	50	4	13,05	0,009766	0,00489	64	6,02	12,50048	0,02946188	0,00059	0,000589			0,05342	0,239472797	25,74234483	0,239613903	25,75751319	0,239613903
14	50	4	13,05	0,014648	0,00489	64	6,02	18,74944	0,0294679	0,00059	0,000589			0,05342	0,359184674	25,74234483	0,359396363	25,75751628	0,359396363
15	50	4	13,05	0,014648	0,0049	64	6,02	18,74944	0,02947392	0,00059	0,000589			0,05342	0,359184674	25,74234483	0,359396406	25,75751938	0,359396406
16	50	4	13,05	0,014648	0,0049	64	6,02	18,74944	0,02947994	0,00059	0,000589			0,05342	0,359184674	25,74234483	0,359396449	25,75752248	0,359396449
17	50	4	13,05	0,019531	0,0049	64	6,02	24,99968	0,02948596	0,00059	0,000589			0,05342	0,478921073	25,74234483	0,479203502	25,75752558	0,479203502
18	50	4	13,05	0,019531	0,0049	64	6,02	24,99968	0,02949198	0,00059	0,000589			0,05342	0,478921073	25,74234483	0,479203559	25,75752868	0,479203559
19	50	4	13,05	0,024414	0,0049	64	6,02	31,24992	0,029498	0,00059	0,00059			0,05342	0,598657471	25,74234483	0,599010655	25,75753178	0,599010655
20	50	4	13,05	0,029297	0,0049	64	6,02	37,50016	0,02950402	0,00059	0,00059			0,05342	0,71839387	25,74234483	0,71881778	25,75753488	0,71881778
21	50	4	13,05	0,043945	0,0049	64	6,02	56,2496	0,02951004	0,00059	0,00059			0,05342	1,077578544	25,74234483	1,078214532	25,75753798	1,078214532
22	50	4	13,05	0,063477	0,00977	64	6,02	81,25056	0,05879132	0,00118	0,001174			0,05342	1,556524138	25,74234483	1,55835434	25,77261336	1,55835434
23	50	4	13,05	0,092773	0,00488	64	6,02	118,74944	0,02939566	0,00059	0,000588			0,05342	2,274893487	25,74234483	2,276230926	25,75747909	2,276230926
24	50	4	13,05	0,12207	0,00977	64	6,02	156,2496	0,05879132	0,00118	0,001174			0,05342	2,993287356	25,74234483	2,996806943	25,77261336	2,996806943
25	50	4	13,05	0,151367	0,00488	64	6,02	193,74976	0,02939566	0,00059	0,000588			0,05342	3,711681226	25,74234483	3,713863372	25,75747909	3,713863372
26	50	4	13,05	0,185547	0,00977	64	6,02	237,50016	0,05879132	0,00118	0,001174			0,05342	4,549811494	25,74234483	4,555161283	25,77261336	4,555161283
27	50	4	13,05	0,219727	0,00488	64	6,02	281,25056	0,02939566	0,00059	0,000588			0,05342	5,387941762	25,74234483	5,391109405	25,75747909	5,391109405
28	50	4	13,05	0,258789	0,00977	64	6,02	331,24992	0,05879132	0,00118	0,001174			0,05342	6,345783908	25,74234483	6,353245448	25,77261336	6,353245448
29	50	4	13,05	0,297852	0,00977	64	6,02	381,25056	0,05879132	0,00118	0,001174			0,05342	7,303650575	25,74234483	7,3122384	25,77261336	7,3122384
30	50	4	13,05	0,336914	0,00977	64	6,02	431,24992	0,05879132	0,00118	0,001174			0,05342	8,26149272	25,74234483	8,271206802	25,77261336	8,271206802
31	50	4	13,05	0,371094	0,00488	64	6,02	475,00032	0,02939566	0,00059	0,000588			0,05342	9,099622989	25,74234483	9,104972777	25,75747909	9,104972777
32	50	4	13,05	0,410156	0,00977	64	6,02	524,99968	0,05879132	0,00118	0,001174			0,05342	10,05746513	25,74234483	10,06929097	25,77261336	10,06929097
33	50	4	13,05	0,449219	0,00977	64	6,02	575,00032	0,05879132	0,00118	0,001174			0,05342	11,0153318	25,74234483	11,02828392	25,77261336	11,02828392
34	50	4	13,05	0,483398	0,00977	64	6,02	618,74944	0,05879132	0,00118	0,001174			0,05342	11,85343755	25,74234483	11,86737513	25,77261336	11,86737513
35	50	4	13,05	0,522461	0,00977	64	6,02	668,75008	0,05879132	0,00118	0,001174			0,05342	12,81130421	25,74234483	12,82636808	25,77261336	12,82636808
36	50	4	13,05	0,561523	0,00977	64	6,02	718,74944	0,05879132	0,00118	0,001174			0,05342	13,76914636	25,74234483	13,78533649	25,77261336	13,78533649
37	50	4	13,05	0,595703	0,00977	64	6,02	762,49984	0,05879132	0,00118	0,001174			0,05342	14,60727663	25,74234483	14,62445225	25,77261336	14,62445225
38	50	4	13,05	0,625	0,00977	64	6,02	800	0,05879132	0,00118	0,001174			0,05342	15,3256705	25,74234483	15,34369083	25,77261336	15,34369083
39	50	4	13,05	0,65918	0,00977	64	6,02	843,7504	0,05879132	0,00118	0,001174			0,05342	16,16380077	25,74234483	16,18280659	25,77261336	16,18280659
40	50	4	13,05	0,688477	0,00977	64	6,02	881,25056	0,05879132	0,00118	0,001174			0,05342	16,88219464	25,74234483	16,90204517	25,77261336	16,90204517
41	50	4	13,05	0,722656	0,00977	64	6,02	924,99968	0,05879132	0,00118	0,001174			0,05342	17,72030038	25,74234483	17,74113638	25,77261336	17,74113638
42	50	4	13,05	0,74707	0,00977	64	6,02	956,2496	0,05879132	0,00118	0,001174			0,05342	18,31895785	25,74234483	18,34049777	25,77261336	18,34049777
43	50	4	13,05	0,78125	0,00977	64	6,02	1000	0,05879132	0,00118	0,001174			0,05342	19,15708812	25,74234483	19,17961353	25,77261336	19,17961353
44	50	4	13,05	0,800781	0,00977	64	6,02	1024,99968	0,05879132	0,00118	0,001174			0,05342	19,6360092	25,74234483	19,65909773	25,77261336	19,65909773
45	50	4	13,05	0,825195	0,00977	64	6,02	1056,2496	0,05879132	0,00118	0,001174			0,05342	20,23466667	25,74234483	20,25845912	25,77261336	20,25845912
46	50	4	13,05	0,844727	0,00977	64	6,02	1081,25056	0,05879132	0,00118	0,001174			0,05342	20,71361226	25,74234483	20,73796787	25,77261336	20,73796787
47	50	4	13,05	0,854492	0,00977	64	6,02	1093,74976	0,05879132	0,00118	0,001174			0,05342	20,95306054	25,74234483	20,9776977	25,77261336	20,9776977

Figure 3. *Values recorded in the file ".dat"*

3. Results and discussion

After thermal stresses according to schedule, the samples were subjected to traction tests, results are presented in Table 1 and Figures 4 ÷ 6.

Tabel 1. *Experimental results*

Sample lots	σ_{max}		σ_r	
	[MPa]	[%]	[MPa]	[%]
I	27,74	100	26,76	100
II	27,66	99,72	26,68	99,70
III	26,78	96,54	25,97	97,05
IV	26,14	94,23	25,17	94,06
V	26,40	95,17	25,53	95,40

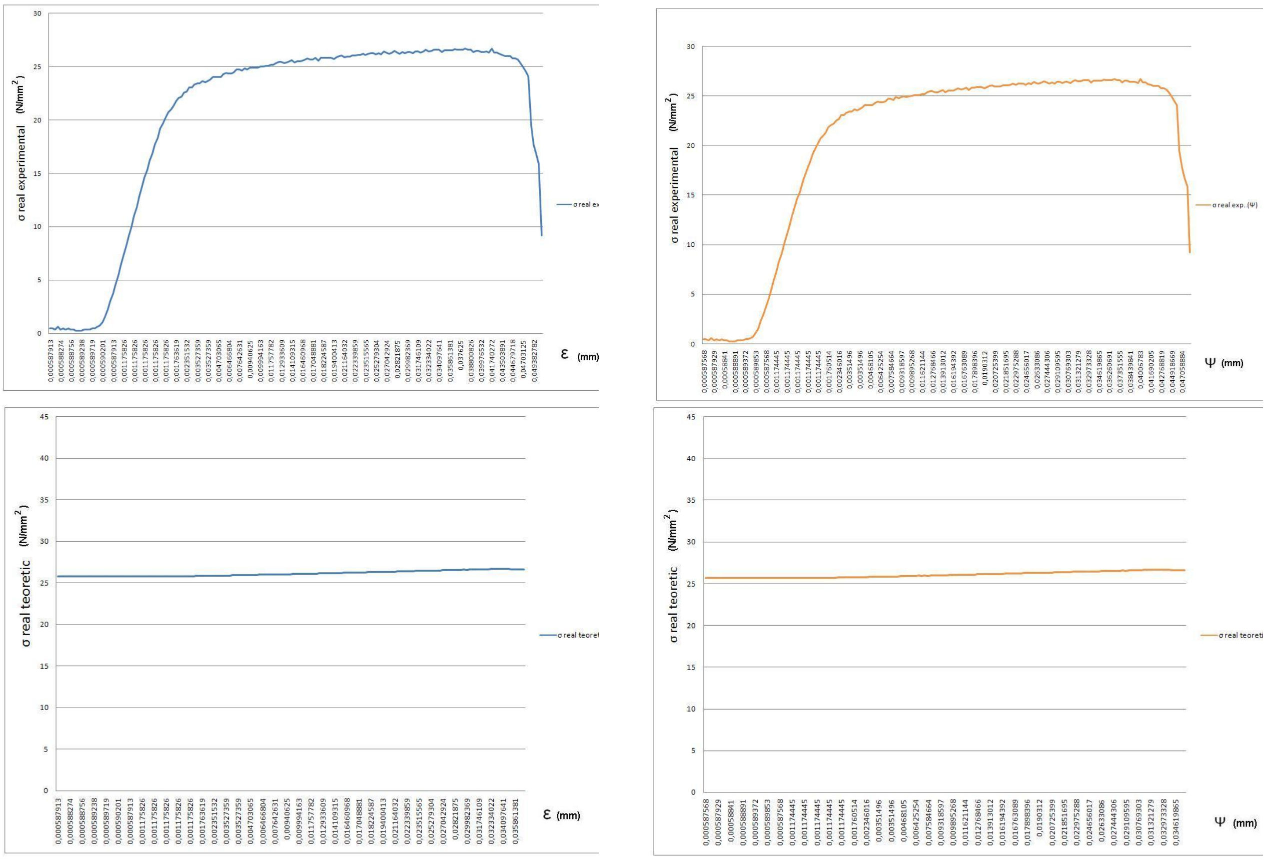


Figure 4. *Graphical representation of experimental results for sample 3 in group IV*

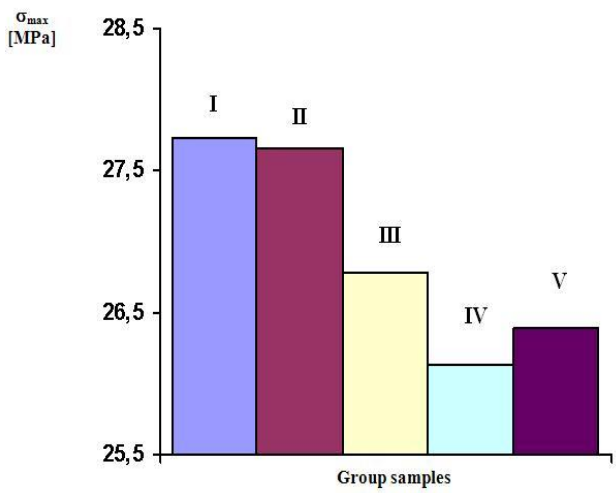


Figure 5. *The influence of thermal stresses on σ_{max}*

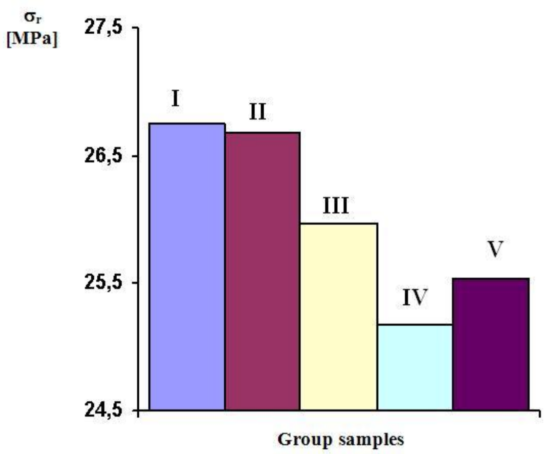


Figure 6. *The influence of thermal stresses on σ_r.*

Analyzing the results is found a reduction of the resistance characteristics from 27.74 MPa for σ_{max}, on samples in delivery state (group I), to 26.14 MPa for samples in group IV (samples subjected to three long cycles of heating-cooling), that corresponds to a reduction of 5.77%, in the case of σ_r values, the decline was from 26.76 MPa to samples from group I to 25.17 MPa for those in group IV, ie 5.95% reduction. Similar results were recorded for specimens in group V were subjected to six short cycles of heating and cooling: σ_{max} = 26.40 MPa (4.83% reduction) and σ_r = 25.53 MPa (4.60% reduction).

4. Conclusions

Composite material type ALUCOBONT is used in plating exterior walls of the buildings and the execution of ornamental ensembles for advertising purposes which is used as a support for various objects.

To check reaction of environmental temperature changes the samples for traction test were subjected to thermal cycles involved heating at 37 °C and cooling to -30 °C, maintaining these temperatures for 60 minutes (cycle "long") and 15 minutes (cycle "short").

The analysis of the results was a decrease in resistance characteristics (σ_{max} and σ_r) with values contained between 0.3% and 5.77%, depending on the number of heating and cooling cycles and applied times to maintain use.

References

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