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QUALITY INDEX FOR NEW MATERIALS

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ABSTRACT
This paper presents an approach of quality index for composite materials based on resins and unclothe textile fibers. The results were obtained experimentally by making measurements over tensile strength, delaminating strength and tearing strength.

1. INTRODUCTION

The problem of saving materials or appropriately using them by rational projects and scientific consumption is becoming a necessity of our life because of the high dimension of our modern industry and raw materials. This is a result of a new concept in engineering and economic practice, namely the ″bases of the rational utilization of the materials″.
In order to carry out this problem, there have been done researches to obtain new materials, that is composite materials. These theoretical and experimental studies set up the main physic-mechanical characteristics, the tests, the specific theoretical studies, the comparison between theoretical and experimental results, the establishing of the utilization domains and finally new researching trends.
Developing these studies became a necessity due to the following reasons: promotion of the terrestrial, naval, railway and air-spatial transport systems, the decreasing of raw materials because of the intense extraction, the high military techniques, the demand for the optimal correlation between performance and costs, respectively technology and costs [1].
The main characteristics of these materials, as for example the physical, chemical, mechanical and technological properties, are studied by the research institutes and by the universities, too.
The concerns with the realization of new materials are a consequence of a tendency for the utilization of qualitative materials obtained by new technologies, and unpolluting materials [2].
The high number of the published studies proves the interest in these materials. Today there are a lot of well-known ranforced materials and polymeric matrices and their combination provide new and high quality materials. The composites result from the association of minimum two unmiscible materials.
The natural fibbers become more and more studied and used as ranforced material for the composites for different utilization areas, where are expected to be used ecological materials.

From this point of view, our researches regarding new materials present their manufacturing and their characteristics.

2. EXPERIMENTAL RESEARCHES

The main objective of our experimental researches was the obtaining of stratified plates from prepolimerised wadding by using the press thermoformation technology [3].
The prepolimerised wadding is made up of 65% natural regenerated unwoven fibbers and 35% phenol-formaldehyde resin [4].
The main parameters studied for the manufacturing of the stratified plates by means of thermoformation technology are: temperature (160 °C, 180 °C and 200 °C), number of layers (1,2 and 3 layers) and thickness (3, 5 and 7 mm).
For each test, we used 5 specimens of different sizes (corresponding to each experiment type) according to the 13 probes of stratified plates and prepolimerised wadding.
We studied the following properties:

a) physical properties: density, mass and volume participations, thermic conductivity, combustibility and acoustic absorption;

b) mechanical properties: tensile strength, delaminating strength, tearing strength.

2.1. Considerations on tensile strength

We used a test agreed by the French Norms NFG07-001 and G37-103.
The experiment is a stretching test until the tearing of the specimen. The shape and dimension of the specimen are presented in figure 1.

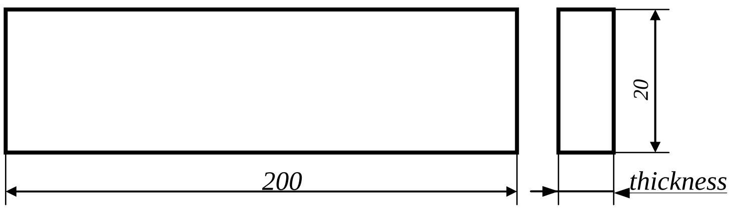


FIGURE 1. THE SHAPE AND DIMENSIONS FOR STRENGTH

The tensile strength was calculated with the following relation:

$$\sigma_r = \frac{F_r}{S_0} [\text{MPa}] \quad (1)$$

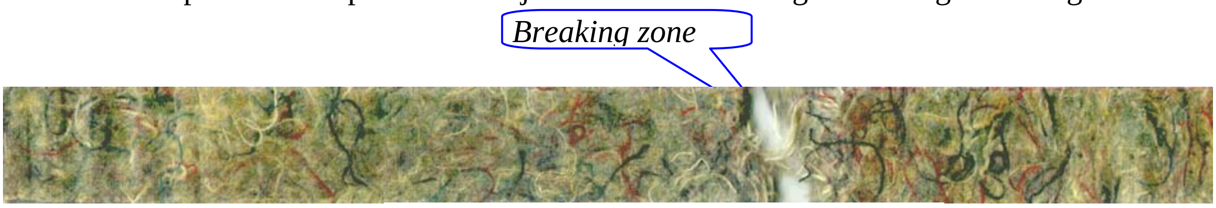
Where:

F_r – the breaking weight [N]; S_0 – the original straight sectional area of the specimen [mm].
The test results are presented in table 1:

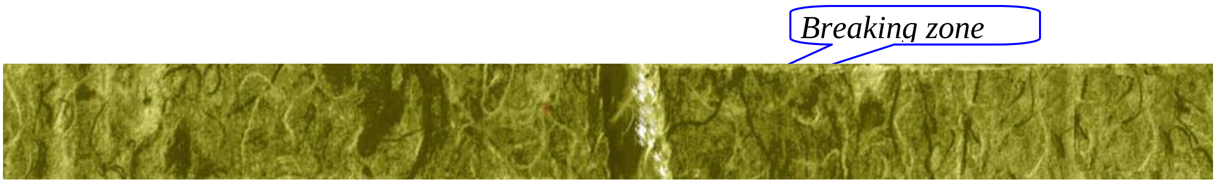
TABLE 1 THE CHARACTERISTICS CONCERNING TENSILE STRENGTH

No. Crt	Speci-men	Parameters			B [mm]	Thick. average [mm]	S_0 [mm^2]	F [N]	σ_r [MPa]	ρ [Kg/m^3]
		No of layers [pie]	Temp [°C]	Thick [mm]						
1	5	1	160	5	19.994	4.99	99.770	110.6	1.1085	251.086
2	1	1	180	3	20.24	3.02	61.126	214.4	3.5116	377.692
3	2	1	180	7	20.04	7.024	140.759	133.64	0.9497	166.679
4	4	1	200	5	20.016	4.934	98.759	106.6	1.0789	202.006
5	9	2	160	3	20	3.076	61.524	1564.4	25.438	754.696
6	3	2	160	7	19.854	6.984	138.652	197.8	1.4270	329.372
7	6	2	180	5	19.958	5	99.792	925	9.270	449.450
8	7	2	200	3	19.97	3.022	60.3634	1388.4	23.034	710.465
9	10	2	200	7	20.16	6.98	140.704	184.9	1.3144	313.203
10	11	3	160	5	20.34	5.08	103.326	1345.2	13.032	649.545
11	12	3	180	3	20.16	2.94	59.284	1777	30.024	1019.39
12	13	3	180	7	19.96	6.98	132.61	1711	12.287	462.171
13	8	3	200	5	20.204	5.04	101.83	1274	12.527	584.945

The aspect of few specimens subjected to tensile strength tests is given in figure 2.



a) Specimen 1 – 1 layer /180°C /3 mm.



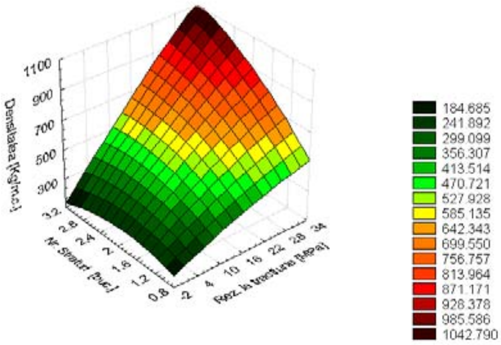
b) Specimen 2 – 1 layer /180°C /7 mm

c) Specimen 5 – 1 layer /160°C /5 mm

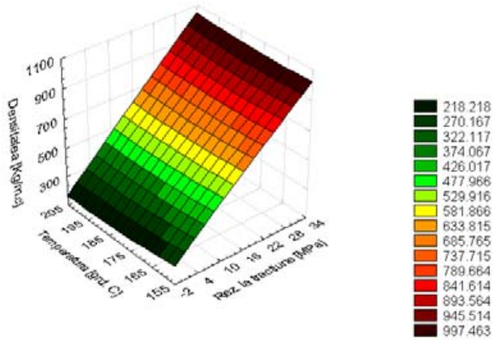
d) Specimen 7 - 2 layers /200°C /3 mm

FIGURE 2 (a, b, c, d). THE ASPECT OF THE SPECIMENS SUBJECTED TO TENSILE STRENGTH TEST

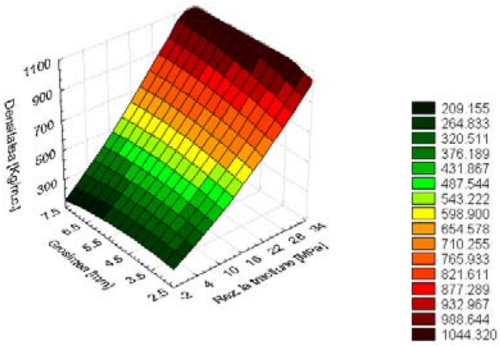
The plloting is presented in figure 3 (a, b, c):



a) Tensile strength
$\sigma_r = f(no.\text{ of layers, density})$



b) Tensile strength
$\sigma_r = f(\text{temp., density})$

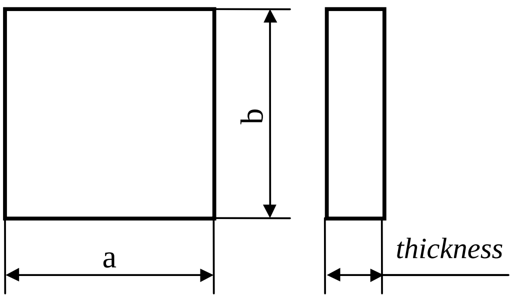


c) Tensile strength
$\sigma_r = f(\text{thickness, density})$

FIGURE 3 (a, b, c). THE GRAPHIC REPRESENTATION OF THE TENSILE STRENGTH

2.2. Considerations on delaminating strength

The objective of the test is to appreciate the cohesion of the composite susceptible to be delaminated, using a firm standard S.F. 1197/87, elaborated by the Cars Design Center.
The shape and dimensions of the specimen are presented in figure 4, and the fixing device for the specimen is presented in figure 5 [5].



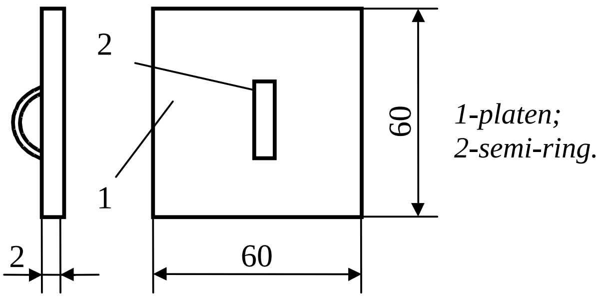


FIGURE 4. THE DIMENSIONS OF THE SPECIMEN

FIGURE 5. THE FIXING DEVICE OF THE SPECIMEN

Figure 6 presents the ensemble specimen-platens before delaminating and figure 7 presents it after delaminating.

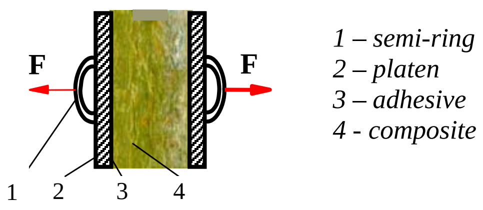


FIGURE 6. THE ENSEMBLE BEFORE DELAMINATING

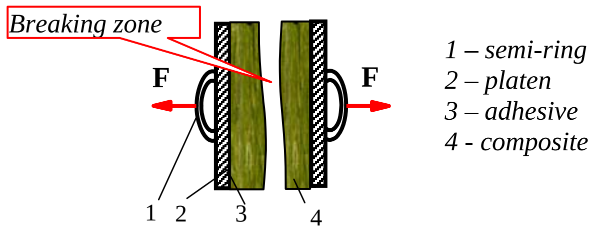


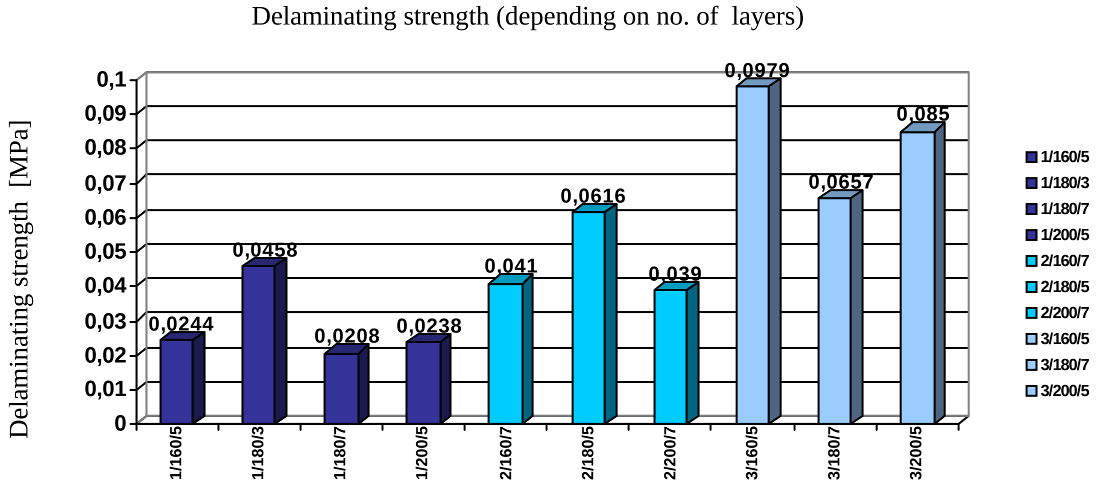
FIGURE 7.THE ENSEMBLE AFTER DELAMINATING

After the tests, we obtained the results presented in table 2:

TABLE 2. THE CHARACTERISTICS CONCERNING THE DELAMINATING STRENGTH

No Crt	*Speci-men*	*Parameters*			a [mm]	*b [mm]*	*S_0 [mm^2]*	*F [N]*	*σ [MPa]*
		No. Layers. [pieces]	*T [°C]*	*Thick. [mm]*					
1	*5*	*1*	*160*	*5*	*60*	*59.2*	*3552*	*86.6*	*0.0244*
2	*1*	*1*	*180*	*3*	*59.4*	*59.6*	*3539.8*	*162*	*0.0458*
3	*2*	*1*	*180*	*7*	*60.2*	*60.6*	*3648.3*	*75.9*	*0.0208*
4	*4*	*1*	*200*	*5*	*59.8*	*60.1*	*3593.7*	*85.5*	*0.0238*
5	*9*	*2*	*160*	*3*	*60.4*	*61*	*3684.4*	*-*	*-*
6	*3*	*2*	*160*	*7*	*59.8*	*58.8*	*3516*	*144.2*	*0.0410*
7	*6*	*2*	*180*	*5*	*59.5*	*59.8*	*3558.5*	*219.2*	*0.0616*
8	*7*	*2*	*200*	*3*	*59.62*	*60.6*	*3613.48*	*-*	*-*
9	*10*	*2*	*200*	*7*	*60.6*	*61.8*	*3745*	*146*	*0.0390*
10	*11*	*3*	*160*	*5*	*60*	*61.4*	*3684*	*360.6*	*0.0979*
11	*12*	*3*	*180*	*3*	*60.7*	*60.9*	*3696.6*	*-*	*-*
12	*13*	*3*	*180*	*7*	*61.1*	*60.1*	*3672*	*241.4*	*0.0657*
13	*8*	*3*	*200*	*5*	*62*	*62.4*	*3869.4*	*328.8*	*0.0850*

In figure 8 there is presented the delaminating strength depending on the number of layers.



Legend
1 /160 /5 – 1 layer /160°C /5mm

FIGURE 8. THE DELAMINATING STRENGTH DEPENDING ON THE NUMBER OF LAYERS

2.3. Considerations on tearing strength

The method defines the conditions of measuring the propagation load for primed tearing, in accordance with the French Technical Standard number D41-1226.
The specimen has the shape and dimensions presented in figure 9:

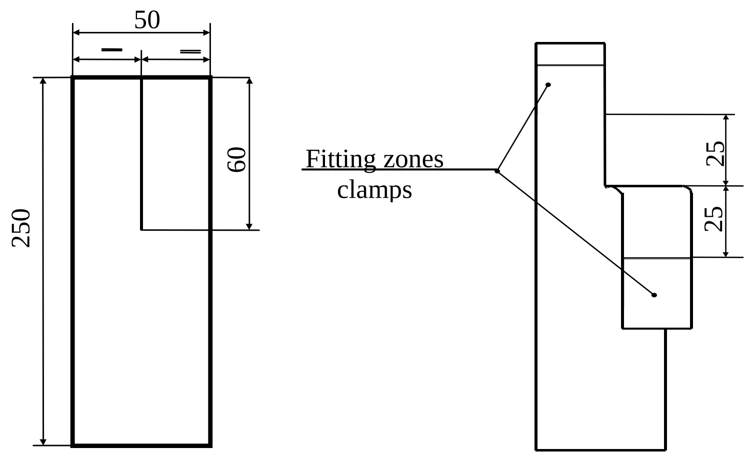


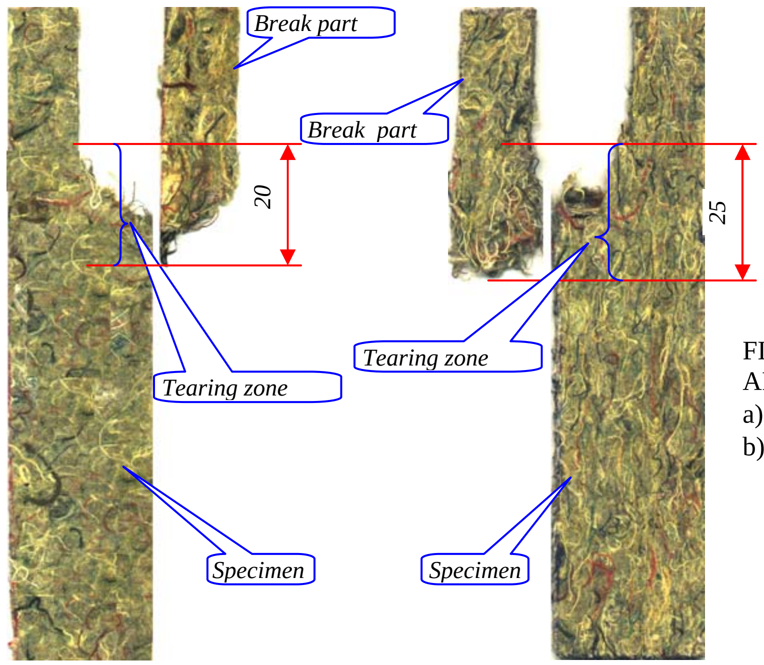
FIGURE 9. THE DIMENSIONS OF THE SPECIMEN FOR TEARING STRENGTH

The attempts results are exemplified in table 3.

TABLE 3. THE CHARACTERISTICS CONCERNING THE TEARING STRENGTH

No Crt.	Speci-men	Parameters		Thick. [mm]	S_0 [mm^2]	F [N]	σ [MPa]	Observations
		No. layers [pieces]	T [°C]					
1	5	1	160	4,94	247	68,3	0,277	Tearing at angle of 45° and gentle delaminating
2	1	1	180	3.08	154	63.46	0.412	Tearing at angle of 45° and gentle delaminating
3	2	1	180	7.06	353	86.3	0.245	Tearing at angle of 15° and gentle delaminating
4	4	1	200	4.96	248	67.7	0.273	Tearing at angle of 45° and gentle delaminating
5	9	2	160	3.02	151	101.2	0.671	Breaking at angle of 90° and gentle delaminating
6	3	2	160	7	350	129	0.369	Tearing at angle of 15° and matching at angle of 90°
7	6	2	180	5.04	252	147.6	0.586	Tearing at angle of 75° and delaminating
8	7	2	200	3.06	153	85.6	0.559	Breaking at angle of 90° and gentle delaminating
9	10	2	200	7	350	111,2	0,318	Tearing at angle of 15° and delaminating
10	11	3	160	5.2	260	215	0.827	Breaking at angle of 90° and delaminating
11	12	3	180	3.06	153	118.5	0.776	Breaking at angle of 90° and delaminating
12	13	3	180	6.98	349	221	0.634	Breaking at angle of 90° and matching
13	8	3	200	4.96	248	199.8	0.806	Breaking delaminating at angle of 90°

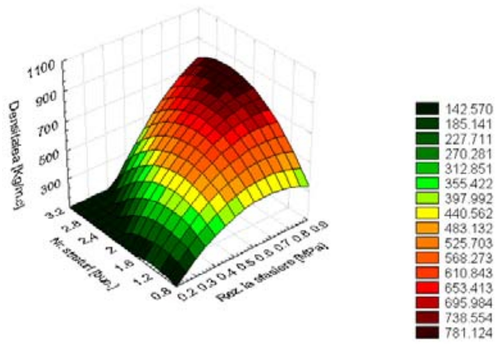
In figure 10 there are presented two of the specimens after the tearing test.



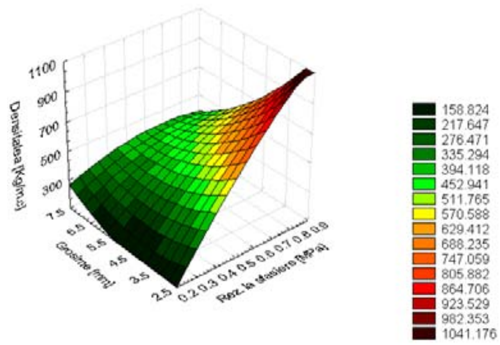
a) b)

FIGURE 10. THE SPECIMEN ASPECT AFTER TEARING TEST
a) SAMPLE 1 – 1 layer/ 180°C/3mm
b) SAMPLE 3 – 2 layer/ 160°C/7mm

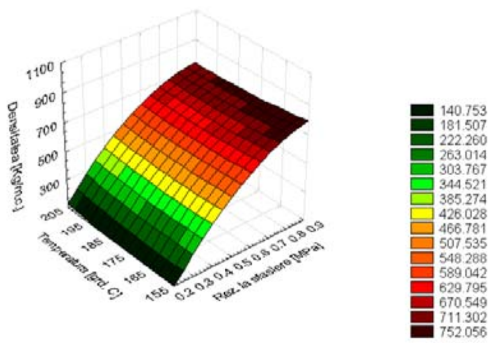
In figure 11 (a, b, c) there is presented the tearing strength depending on the technological parameters for the composites.



a) Tearing strength
$\sigma_{sf} = f(\textit{no.}\text{ of layers, density})$



b) Tearing strength
$\sigma_{sf} = f(\text{temp., density})$



c) Tearing strength
$\sigma_{sf} = f(\text{thickness, density})$

FIGURE 11 (a, b, c). THE PLOTTING OF THE TEARING STRENGTH

3.CONCLUSIONS

3.1.Conclusions concerning the materials behavior to the traction test

- the resistance average to traction is maximum at maximum density of the composite and minimum at the minimum density of the composite;
- the resistance average to traction is higher for the composites with 3 layers than for those with 2 layers except probe no. 7 and higher than those with only one layer;
- analyzing the aspect of the breaking zone, we can notice that this has an irregular shape with a snatching aspect, except probes no. 7,11, 9 and 12 which have the highest densities, and the breaking zone of which is almost perpendicularly on the specimen edges.

3.2.Conclusions concerning the average resistance to the delaminating test

- the necessary weight for delaminating increases directly proportional to the number of layers and the composites density;
- delaminating effort is proportional to the composites density;
- delaminating effort is higher at 3 layers composites than 2 layers composites and 1 layer composites;
- the specimens 9,7 and 12 haven't been delaminated because the delaminating weight is higher than the adhesion force between composite and platens, due to their thickness of 3 mm.

3.3.Conclusions concerning the materials behavior to the tearing test

- it can be seen that the length of the tearing zone is directly proportional to the composites density;
- for the majority of the specimens, the tearing effect is accompanied by the delaminating effect, followed by the specimens breaking at different angles;
- at specimens with high density, the tearing effect is replaced by the breaking effect;
- it's impossible to have a general tearing rule because the textile fibers from the composite are chaotically represented;

This material is destined to be used for the manufacturing of some car parts and it doesn't create problems when it comes to the environment.

4. BIBLIOGRAPHY

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