HIGH PERFORMANCE WOOD COMPOSITES

CTBA
Centre Technique du Bois et de l'Ameublement

SYLVADEC
MADAME JEZEQUEL
PARC D'ACTIVITE DE L'ESTUAIRE
56 190 ARZAL

REPORT FINDINGS

IMMERSION TESTS, FLEXURAL STRENGTH TESTS AND DIMENSIONAL VARIATION TESTS ON WOOD COMPOSITE MATERIAL

Pôle Construction
CIAT/Marcel DENANCE
Tel: 05.56.43.63.24
Fax: 05.56.43.64.86

Confidential Report
3 June 2003

Information above has been translated from the original French Document as presented by CTBA and is as accurate a translation as possible.

This report consists of 15 pages + appendices

CTBA – Allée de Boutaut – B.P. 227 – 33 028 BORDEAUX CEDEX
Sire 775 680 903 00017 – CODE NAF 731 Z

CTBA
Sylvadec France
PC.37.269 – MD/FD/2003.3700125
Bordeaux, 3 June 2003
Confidential Report

At the request of Sylvadec, several laboratories - Pôle Construction at CTBA in Bordeaux, have carried out evaluation tests on wood composite material from STRANDEX.

The mechanical laboratory has carried out immersion and flexural strength tests (with and without prior treatment) dimensional variations and density tests. The findings are in report **F-R/68/02/132/151/1** (sent out previously), **F-R/68/02/132/152/2** (herewith as appendix to this report)

The Entomology laboratory has carried out resistance tests using the Saintonge Termite. The findings are in report **PC/66/138/02Z/a/1**.

According to SILVADEC, STRANDEX is a composite mixture of sawdust (approx 60% of the mixture) and polyethylene. It is extruded into profiles. The material used was in solid blocks of 15mm nominal thickness.

The purpose of the tests outlined in this report is to evaluate:

- The performance of the material following extended weathering
- The hygrothermic stability of the material
- Resistance to termites

1. PERFORMANCE FOLLOWING IMMERSION

Taking into account the critical role of water in wood based materials, we must measure the swelling (as the excess calls into question the structure of the material) and the recovery of water which may be an indicator of susceptibility to fungus.

Taking into account the newness of the material we have called on the Norm NF EN 317 (sample of 8 test tubes) but the usual time (24 hours) has been modified in order to attempt to evaluate the effect of time on the samples behaviour when immersed. We have thus taken measurements in time following the grid listed below: (days)

1	2	4	7	14	28	56	112

At the end of the cycle the thickness of the swelling is 4.7%, and the resumption of mass is 10.9%.

The intermediary measurements show a strong correlation between time (FISCHER variable at least equal to 6; for a threshold of 1.96) to allow the establishment of the following two predictable laws:

- Swelling

$G = 0.45 \times t^{0.48}$

t: time in days
G: swelling in %

For 1200 days, we would obtain thus a swelling of around 13%

- resumption of mass

$$R = 1.2 \times t^{0.47}$$

t: time in days
R: resumption of mass in %

For 1200 days, we would obtain thus a resumption of mass of around 33%

In the 2 cases, it would be risky to extrapolate beyond this length of time.

Conclusion:

By way of comparison, after 24 hours, a panel of CTB-H of this thickness range has a limit of swelling in thickness of 10%. On the other hand, the STRNEX material tested here has a swelling of only 0.4% (value limited by measuring accuracy).

Between the two materials there is therefore a ratio of 1 to more than 20.

The product appears be impermeable to water; which is one of the guaranteed elements of good performance in bad weather.

2. FLEXURAL STRENGTH

The reference method is the Norm NF EN 310 (Flexural strength - 3 points adapted for the processing control, the sample is 6 test tubes)
The tests are carried out at 20°C and at 65% relative humidity.

2.1 Initial State

The breaking stress level is for the best particle boards for humid conditions (conforming to NF EN 312-7) since the constraint in this range of thickness is 20 MPa[1]).

The apparent modulus of elasticity, on the other hand is appreciably higher (approximately 50%: 4500 against 3000 MPa).

However, the rigidity is noticeably less than that of solid wood (from 10 to 16 000 MPa according to the variety).

The spread of the results appears very weak (coefficient of variation is less than 3% that of solid wood is much higher for all flexural strength characteristics). This weak spread would however need to be confirmed by the results of manufacture; it is possible that the spread inter - batch would be higher than the spread intra-batch.

Finally, there is almost isotropy (equally elastic in all directions) when flat since these two properties in the test tubes are very close in both directions (this is the case for the composite panels but not solid wood which has a none isotropic ratio (having properties that differ according to the direction of measurement -length and breadth) above 30).

Conclusion:

The flexural strength properties of the material are:

- **a resistance equivalent to the best particle boards on the European market,**

- **A far superior rigidity (50%)**
- **A quasi isotropy (equally elastic in all directions)**

2.2 Tests

The tests are conventional and based on external use in normal conditions.

The control of the effect of each test refers to the flexural strength test in accordance with EN 310.

The tests have been carried out on the test tube only where the large axis was parallel with the extrusion.

Note: The quasi isotropy (equally elastic in all directions) flexibility properties justify this choice.

2.2.1 Cyclical Test:

Changes in temperature and humidity similar to those that the product would be exposed to outside during its lifetime were re-created.

2.2.11 Methodology

The test known in France as V 313 is used. The method is defined by the Norm NF EN 321.

The reference method is made up of the following 3 cycles:

- 3 days immersed in water at 20°C
- 1 day of freezing (-15°C)
- 3 days in a ventilated drying oven at 70°C

a cycle is therefore one week.

For a better valuation of behaviour over time the following number of cycles was used.

- 1 cycle
- 2 cycles

- 4 cycles
- 8 cycles
- 16 cycles

2.2.1.2 Results

At the end of 8 weeks:

- The average constraint increased by 4.2% (significant taking into account the very weak dispersion of this property)
- The modulus of elasticity is reduced by 1.2% but the drop in performance is not significant
- The breaking force increased by 7.3%, but taking into account the increased dispersion, this increase is not significant

Also, taking into consideration the repetition of the cycles, it is concluded that, for the 3 properties (constraint, modulus of elasticity and breaking force) it does not have a significant influence.

At the end of 16 weeks:

- The resistance is reduced by 5.5%, this is significant at nearly 95%
- The modulus of elasticity is significantly reduced (by nearly 20%)
- The breaking force increased by 11%, significantly at nearly 95%.

Conclusion:

At the end of 8 weeks of the test V 313 (combining heat and humidity) the STRANDEX material does not break down significantly.

At the end of 16 weeks the resistance and especially the rigidity has decreased significantly. On the other hand the work to make a complete break increases by 11%, this is significant at practically 95%.

In commercial applications one can therefore expect the product to age satisfactorily when used in conditions combining both heat and humidity if:

- ***the product is used not under stress (e.g. flooring laid on a continuous support)***

- ***the product is used under loads (according to the EUROCODE 5).***

Note:

However, for working use, the requirements of the profiles should refer to an initial evaluation using bigger test-tubes and on profiles or even working models (in accordance with Norm NF EN 1195)

Use under prolonged restriction should only be considered after an estimate of the creep characteristics of the profile material (test in accordance with NF EN 1156).

2.2.2 Heat Exposure

The test tubes were stabilised in a drying oven at 70°C. This temperature corresponds to the maximum value possible from the effect of exposure to sunlight.

The flexural strength test is undertaken at room temperature as soon as the material is taken out of the drying oven.

We found:

- A reduction in the breaking constraint of more than 32%
- A reduction in the modulus of elasticity of more than 45%
- An increase in the breaking force of more than 26%

All of these variations are significant.

Conclusion:

Under extreme heat, the material STRANDEX appears not to perform as well from the aspect of resistance or shaft under heavy load. If the profiles are used in hot conditions (either temporary or permanent) their dimension must be taken into account. Moreover, in commercial

applications a more systematic study (linking notably modulus and breaking constraint as well as temperature spread) is recommended. On the other hand, under the aspect of security to shock, the increase in braking force highlights an improved performance compared to that noted at the standard temperature of 20°C.

2.2.3 Exposure To Cold:

The test tubes are stabilised at (-25°C)
As before the flexural strength test is carried out a room temperature as soon as the material is taken out of the drying oven.

Three flexural strength properties are measured:

- An increase of more than:
  - 33% for the breaking constraint
  - 46% for the modulus of elasticity
- A decrease of :
  - 21% for the breaking force

The results compared to those at 70°C are symmetrical compared to 0. This gives the following proportionate conclusions:

- Better performance under a heavy load
- Not as good a performance under shock.

Conclusion

If the profiles made from this STRANDEX material are used outside in a cold climate (either permanent or temporary) and if these profiles are used vigorously and notably in ensuring peoples safety (floorboards, balustrade railings) the material's weakness must be taken into account. However the loss of performance in breaking force at -25°C is relatively weak. As the rigidity and resistance are improved, one can say that the performance is satisfactory.

2.2.4 Exposure To Ultra – Violet Light

The three flexural strength properties have been improved between 2.5 and 3.5%, but this increase, taking into account the spread between the test tubes, is not significant.

Note: we have not made a judgment on the test tubes.

Conclusion:

The STRANDEX profiles are not really sensitive to Ultra-Violet light. This conclusion applies to walls (15mm thick or more), the surface coating eventually decayed only slightly in comparison to the thickness of the test tubes.

For profiles with thin wall of 5m or less, a complementary study is recommended (but the control of performance will no doubt not be done by flexural strength but more likely by vigorous perforation).

3. HYGROTHERMIC STABILITY

The reference method is defined in the Norm NF EN 318 of May 2002.

The test findings are in the report No. **F-R/68/02/132/151/1** (herewith in appendix)

3.1 Essential elements of the Method

We evaluate the dimensional variations of the profiles in the direction of the extrusion as well as in the thickness.

3.1.1 Climatic Exposure

We set out two sets of test tubes according to the sequence laid out in the following table:

	Test Tubes Set 1		Test Tubes Set 2	
Sequence	(t±1)°C	(HR±3) %	(t±1)°C	(HR±3) %
1	20	30	20	85
2	20	65	20	65
3	20	65	20	30
T: temperature of surroundings HR : relative humidity				

Remarks:

The norm NF En 318 uses test tubes 300mm in length or longer. In this case the nominal length of the test tubes was 100mm.

3.1.2 Measurements:

At the end of sequences 2 and 3 and once the test tubes have been stabilised, we can measure:

- their length
- their thickness

3.1.3 Use of Measurements

For each test tube, we can calculate the relative variation of length ßl (or the thickness) according to the following formula:
At the end of sequences 2 and 3 and once the test tubes have been stabilised, we can measure:

$$\beta l_{65.X} = 1000 \times \frac{l_x - l_{65}}{l_{65}}$$

l : length or thickness of test tube
x : index for relative humidity of conditions : 30% or 85%
65 : Index for relative humidity of conditions 65%

Note:

NF EN includes the calculation of the relative variation in thickness in %. Here, we have used the same unit as the length in order to assist the comparison

3.2 Results

3.2.1 Relative variation in the two standardised ranges

The results are shown in the table below.

Range of Variation of Relative Humidity	Average Mm/m		Variation Coefficient %	
	Length	Thickness	Length	Thickness
Relative Humidity of 65 to 85%	1.0	2.0	27	228
Relative Humidity of 65 to 30%	-1.0	-1.9	63	62

Notes:

For the thickness in the range of 65 to 85%, the dispersion of 228% is an abnormal result.

One should note that the dimension of the test tubes results in taking measurements that are limited by the instruments used.

On can only therefore consider these results as an approximate estimate.

3.2.2 Synthetic Results

In order to simply the presentation we have undertaken the following operations:

- absolute values of variation of two ranges of conditions

- determination of a characteristic value by integrating the dispersion

The following operations were undertaken:

- Calculate the average standard deviation Sm

From the two ranges of conditions :

$$S_m = \left(\frac{S^2_{65\text{-}30} + S^2_{65\text{-}85}}{2} \right)^{½}$$

- calculation of a characteristic high value VD95 according to:

$$VD_{95} = \overline{VD} + 1.90 \times S_m$$

$\overline{VD}$: average dimensional variation

We reach the following two figures:

- 3 mm/m for the direction of the extrusion
- 10.2 mm/m for the thickness

The second value, although three times the first, has little importance, at least for most uses.

The first is critical for using long lengths such as floor boards.

As an indication, the values for particle board are as follows:

CTB-H panel: approx 3.5 mm/m in the plane and 40 mm/m for the thickness
CTB-S panel: approx 3.5 mm/m in the plane and 64 mm/m for the thickness

3.2 Conclusions:

It seems that on the level STRANDEX's performance is similar to that of particle board. It is thus necessary in the event of assembled joints, to allow for movement. Taking into account the isotropy of STRANDEX in relation to other properties this recommendation applies to the two directions of the plane. As for the extent of the play it depends on the moisture of the profile at the time of its implementation.

For stabilised sections at 65% relative humidity the play should not be lower than 1.5mm/m and for drier sections a value of 3 mm/m should be assumed.

On the other hand, for the thickness, the dimensional variation is 4 to 6 times weaker than that of particle board and 3 times weaker than that of solid wood.

One can therefore say that the instability of the thickness will practically never create any practical problems.

CTBA
Sylvadec France
PC.37.269 – MD/FD/2003.3700125
Bordeaux, 3 June 2003
Confidential Report

4 - RESISTANCE TO TERMITES

4.1 Methodology

The reference for the evaluation of the test method is taken from the Norm NF EN 118.

4.1.1 Principle

A surface of the test-tube is exposed to Saintonge Termites for a given length of time, at the end of which the depth of the attacked surface is measured. This follows a reference of 5 levels from 0 to 4.

4.1.2 Samples

The tests were carried out on:

- 6 new test tubes
- 6 test tubes having undergone the accelerated weathering test (ultraviolet radiation for 2 x 3 weeks)
- 6 test tubes having undertaken 2 cyclical tests in accordance with EN 231 (known as V313)

4.2 Results

- Reference sample of sapwood of Norwegian Pine - 3 references 4 (out of 3)
- New test tubes with STRANDEX 2/6 classified 1, the rest classified 0.
- Test tubes aged by UV: 4/6 classified 1, the rest 0
- Test tubes aged by V313 : 6/6 classified 1

4.3 Conclusion

We consider that the material is resistant to attack by Saintonge Termites if at the most one test tube (in 6) is classified 2.

In this case none of the test tubes, no matter what condition (new or aged) reaches this level.

We consider that the material is resistant to Saintonge Termites in its natural state as well as over time.

Moreover, the test shows that resistance to xylophages insects is positively correlated to resistance to Saintonge Termites.

5 - DENSITY

The assessment can be found in appendix three of report No.
F-R/68/02/132/151/2

The density of solid STRANDEX is 1217 and the variation coefficient is approximately 0.7%.

The density is of a high level, in the same order of magnitude as a wooden panel - cement and practically 50% more than that of processed panels (MDF, OSB)

This raised level indicates screws and other inserts will be held well. However their implementation must be adapted to this density (preformed holes, distance in relation to the edge of the plank….)

Note: if the product is extruded into tubular profiles the density could be notably reduced.

The dispersion is very weak. However, with test tubes coming from the same batch the result obtained comprises an estimate of the dispersion intra-batch. It is therefore possible that the dispersion inter-batch may be greater.
It should be noted that this weak dispersion intra-batch could be a quality criteria to follow up. This assumes an analysis is made of the quality control results.

CTBA
Sylvadec France
PC.37.269 – MD/FD/2003.3700125
Bordeaux, 3 June 2003
Confidential Report

6 OVERALL CONCLUSION OF THE REPORTS F-R 68/02/132/151/1, F-R 68/02/132/151/2 and PC/66/138/02Z/a/1

STRANDEX material has excellent merits concerning its performance in outside conditions and its resistance to termites in all conditions. For a complete understanding of the material, resistance to biological agents (insects and fungus) needs to be confirmed (tests are in the course of being completed).

If the mechanical tests undertaken give an indication of the flexural strength performance, they are above all intended to give a base for control of the manufacturing process.

The high density of the material leads us to believe there is good resistance to screws and other inserts (as long as they are inserted appropriately.)

For structural use, better suited tests, using test tubes of a bigger size (NF EN 789) even on models of a normal size (in accordance with NF EN 1195 for use with planks) would be necessary in order to evaluate performance with instantaneous loads.

However, for this type of use, the reaction of STRANDEX material to temperature (a slight embrittlement due to the cold but moreover an important loss of rigidity and resistance due to heat) must be taken into account.

Finally if use under load over a long period is envisaged, a specific evaluation of creep in accordance with XP ENV 1156 will be required. Indeed, for a wood composite material the experiment demonstrates that the finer its particles the greater the creep. Under these conditions and in the absence of more knowledge, STRANDEX must for the moment be excluded from this use

Woodwork Shop Engineer – Panels
Marcel DENANCÉ

CTBA
Sylvadec France
PC.37.269 – MD/FD/2003.3700125
Bordeaux, 3 June 2003
Confidential Report

APPENDIX

Test Report No F-R/68/02/132/151/2

CTBA
Centre Technique du Bois et de l'Ameublement
Bordeaux Office
BP 227
33028 Bordeaux Cedex

PÔLE CONSTRUCTION

Mechanical Laboratory

Translation

Test Report No. F-R / 68 / 02 / 132 / 151 / 2 Date: 15.05.2003

Client: Sylvadec
2 rue des Charmes
44190 Clisson Cedex France

Order Date: 21.01.2002

Test Report

Physical and mechanical tests on wood composite material
- To determine dimensional variations following variations in relative humidity
- To determine flexural strength and density characteristics

CTBA
Sylvadec
Bordeaux 15.05.03
Test report No. F-R /68/02/132/151/2

Test Report

Physical and mechanical tests on wood composite material

1. Description of Samples

Table 1: Characteristics of sample tested

Sample Reference	68/02/132/151
Manufacturer	Sylvadec
Factory	Clisson
Sample taken by	The Manufacturer
Samples received	26/07/02 (batch 1) 09/09/02 (batch 2)
Nominal thickness (mm)	15.8
Length (mm)	367
Width (mm)	50

The samples were cut by the manufacturer

CTBA
Sylvadec
Bordeaux 15.05.03
Test report No. F-R /68/02/132/151/2

2. Test Methods

2.1 To determine the dimensional variations from variations in relative humidity in accordance with methodology of Norm NF EN 318 of May 2002.
2.2 To determine flexural strength and the modulus of elasticity in accordance with the methodology of Norm NF EN 310 of June 1993 after accelerated aging test for the said cyclical method in accordance with the methodology of Norm NF EN 321 of January 2002 over a duration of 16 weeks.
2.3 To determine the density of the material in accordance with Norm NF EN 323 of June 1993.

3. **Results**: The complete detailed results are given in appendix 1 and 2.

3.1 Calculation of dimensional variations

Variation 30% -65%-85%	Average
Length mm/m 65% to 30%	-1.34
Length mm/m 65% to 85%	1.03
Thickness mm/m 65% to 30%	-0.18
Thickness mm/m 65% to 85%	0.32

Variation 30% -65%-85%	Average
Length mm/m 65% to 30%	-1.26
Length mm/m 65% to 85%	0.57
Thickness mm/m 65% to 30%	-0.16
Thickness mm/m 65% to 85%	0.22

Humidity	Average
After Cycles at 85%	2.87
After Cycles at 30%	2.94

3.2 Flexural Strength after 16 weeks of cycle V313

RESULTS OF FLEXURAL STRENGTH TESTS						
Longitudinal direction after 16 weeks of cycle V313	Flexural Resistance in MPa		Modulus in MPa		Breaking Force in N.mm	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
	22.3	0.7	3591	73	5380	256

3.3 Density

Density (kg/m3)	
Average	1217
Standard Deviation	8

Technician in charge of tests
Karine PAIOLA

Technical Manager
Fréderic SIMON

APPENDIX 1

Cycles 30%/ - 65%/-85%

Long Direction	Long Pt. 1/2 (mm)	Long Pt. 2/3 (mm)	Average (mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Average (mm)
				Test Tube 1			
Cond. 20°C – 30% Humidity	99.80	100.55	**100.18**	15.68	15.70	15.70	**15.69**
Cond. 20°C – 65% Humidity	99.84	100.67	**100.26**	15.75	15.75	15.75	**15.75**
Cond. 20°C – 85% Humidity	99.89	100.74	**100.32**	15.80	15.79	15.79	**15.79**
				Test Tube 2			
Cond. 20°C – 30% Humidity	100.22	99.05	**99.64**	15.72	15.72	15.80	**15.75**
Cond. 20°C – 65% Humidity	100.31	99.31	**99.81**	15.80	15.77	15.80	**15.79**
Cond. 20°C – 85% Humidity	100.45	99.42	**99.94**	15.78	15.78	15.67	**15.74**
				Test Tube 3			
Cond. 20°C – 30% Humidity	99.34	100.86	**100.10**	15.75	15.72	15.80	**15.76**
Cond. 20°C – 65% Humidity	99.44	100.93	**100.19**	15.75	15.75	15.80	**15.77**
Cond. 20°C – 85% Humidity	99.54	101.00	**100.27**	15.78	15.78	15.82	**15.79**
				Test Tube 4			
Cond. 20°C – 30% Humidity	100.00	100.66	**100.33**	15.70	15.70	15.70	**15.70**
Cond. 20°C – 65% Humidity	100.10	100.70	**100.40**	15.70	15.70	15.70	**15.70**
Cond. 20°C – 85% Humidity	100.19	100.79	**100.49**	15.70	15.70	15.70	**15.70**
				Test Tube 5			
Cond. 20°C – 30% Humidity	100.15	99.72	**99.94**	15.75	15.70	15.70	**15.72**
Cond. 20°C – 65% Humidity	100.36	99.82	**100.09**	15.72	15.70	15.75	**15.72**
Cond. 20°C – 85% Humidity	100.46	99.90	**100.18**	15.71	15.70	15.69	**15.70**
				Test Tube 6			
Cond. 20°C – 30% Humidity	100.24	100.01	**100.13**	15.75	15.75	15.80	**15.77**
Cond. 20°C – 65% Humidity	100.45	100.20	**100.333**	15.70	15.75	15.75	**15.73**
Cond. 20°C – 85% Humidity	100.60	100.30	**100.45**	15.91	15.93	15.93	**15.92**
				Test Tube 7			
Cond. 20°C – 30% Humidity	100.39	99.35	**99.87**	15.65	15.65	15.65	**15.65**
Cond. 20°C – 65% Humidity	100.57	99.48	**100.03**	15.70	15.70	15.70	**15.70**
Cond. 20°C – 85% Humidity	100.67	99.60	**100.14**	15.74	15.72	15.75	**15.74**
				Test Tube 8			
Cond. 20°C – 30% Humidity	100.45	99.93	**100.19**	15.68	15.65	15.70	**15.68**
Cond. 20°C – 65% Humidity	100.67	100.02	**100.35**	15.70	15.70	15.70	**15.70**
Cond. 20°C – 85% Humidity	100.78	100.19	**100.49**	15.76	15.70	15.73	**15.73**

Cycles 30%/ - 65%/-85%

Long Direction	Long Pt. 1/2 (mm)	Long Pt. 2/3 (mm)	Average (mm)	Thickness 11 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Average (mm)
				Test Tube 9			
Cond. 20°C – 30% Humidity	100.10	100.13	**100.12**	15.80	15.75	15.75	**15.77**
Cond. 20°C – 65% Humidity	100.03	100.02	**100.03**	15.70	15.70	15.67	**15.69**
Cond. 20°C – 85% Humidity	99.89	99.89	**99.89**	15.67	15.67	15.64	**15.66**
				Test Tube 10			
Cond. 20°C – 30% Humidity	100.38	100.40	**100.39**	15.85	15.80	15.85	**15.83**
Cond. 20°C – 65% Humidity	100.29	100.34	**100.32**	15.80	15.80	15.80	**15.80**
Cond. 20°C – 85% Humidity	100.18	100.19	**100.19**	15.79	15.78	15.78	**15.78**
				Test Tube 11			
Cond. 20°C – 30% Humidity	100.43	99.62	**100.03**	15.80	15.80	15.80	**15.80**
Cond. 20°C – 65% Humidity	100.39	99.56	**99.98**	15.76	15.77	15.78	**15.77**
Cond. 20°C – 85% Humidity	100.29	99.46	**99.88**	15.70	15.72	15.73	**15.72**
				Test Tube 12			
Cond. 20°C – 30% Humidity	99.58	100.18	**99.88**	15.80	15.85	15.85	**15.85**
Cond. 20°C – 65% Humidity	99.52	100.10	**99.81**	15.85	15.80	15.83	**15.83**
Cond. 20°C – 85% Humidity	99.32	100.00	**99.66**	15.80	15.78	15.78	**15.79**

		Test Tube 13						
	Cond. 20°C – 30% Humidity	100.10	100.28	**100.19**	15.75	15.75	15.75	**15.75**
	Cond. 20°C – 65% Humidity	100.05	100.22	**100.14**	15.68	15.70	15.70	**15.69**
	Cond. 20°C – 85% Humidity	99.90	100.09	**100.00**	15.67	15.68	15.69	**15.68**
		Test Tube 14						
	Cond. 20°C – 30% Humidity	100.38	100.36	**100.37**	15.80	15.75	15.80	**15.78**
	Cond. 20°C – 65% Humidity	100.34	100.33	**100.34**	15.77	15.75	15.80	**15.77**
	Cond. 20°C – 85% Humidity	100.22	100.24	**100.23**	15.75	15.72	15.78	**15.75**
		Test Tube 15						
	Cond. 20°C – 30% Humidity	100.95	99.84	**100.40**	15.80	15.80	15.80	**15.80**
	Cond. 20°C – 65% Humidity	100.90	99.80	**100.35**	15.80	15.80	15.80	**15.80**
	Cond. 20°C – 85% Humidity	100.78	99.62	**100.20**	15.79	15.83	15.75	**15.79**
		Test Tube 16						
	Cond. 20°C – 30% Humidity	99.80	99.80	**99.80**	15.80	15.75	15.80	**15.78**
	Cond. 20°C – 65% Humidity	99.76	99.77	**99.77**	15.78	15.69	15.80	**15.76**
	Cond. 20°C – 85% Humidity	99.68	99.65	**99.67**	15.68	15.70	15.73	**15.70**

CTBA
Sylvadec
Bordeaux 15.05.03
Test report No. F-R /68/02/132/151/2

APPENDIX 2

Results Table For Dimensional Variations

Variation 30%-65%-85%	Test Tube 1	Test Tube 2	Test Tube 3	Test Tube 4	Test Tube 5	Test Tube 6	Test Tube 7	Test Tube 8	Average
Length mm/m 65% to 30%	-0.80	-1.75	-0.85	-0.70	-1.55	-1.99	-1.55	-1.54	**-1.34**
Length mm/m 65% to 85%	0.60	1.25	0.85	0.90	0.90	1.24	1.10	1.40	**1.03**
Thickness in % 65% to 30%	-0.36	-0.27	-0.06	0.00	-0.04	-0.21	-0.32	-0.15	**-0.18**
Thickness en % 65% to 85%	0.28	0.30	0.17	0.00	0.15	1.21	0.23	0.19	**0.32**

Variation 85%-65%-30%	Test Tube 9	Test Tube 10	Test Tube 11	Test Tube 12	Test Tube 13	Test Tube 14	Test Tube 15	Test Tube 16	Average
Length mm/m 65% to 30%	-1.35	-1.30	-1.00	-1.50	-1.40	-1.05	-1.49	-1.00	**-1.26**
Length mm/m 65% to 85%	0.90	0.75	0.50	0.70	0.55	0.35	0.45	0.35	**0.57**
Thickness in % 65% to 30%	-0.19	-0.11	-0.34	-0.25	-0.08	-0.15	0.00	-0.17	**-0.16**
Thickness en % 65% to 85%	0.49	0.21	0.19	0.04	0.36	0.06	0.06	0.34	**0.32**

Humidity Results Table

Humidity in %	Test Tube 1	Test Tube 2	Test Tube 3	Test Tube 4	Test Tube 5	Test Tube 6	Test Tube 7	Test Tube 8	Average
Initial mass in g	289.18	288.72	290.41	289.17	291.27	288.55	288.14	288.62	
Final Mass in g	281.42	280.66	283.39	281.36	282.58	280.02	280.19	280.80	
Humidity	2.76	2.87	2.84	2.78	3.08	3.05	2.84	2.78	**2.87**

Humidity in %	Test Tube 9	Test Tube 10	Test Tube 11	Test Tube 12	Test Tube 13	Test Tube 14	Test Tube 15	Test Tube 16	Average
Initial mass in g	291.30	291.25	291.44	289.98	289.98	289.07	288.63	290.93	
Final Mass in g	282.85	282.72	283.20	281.45	281.85	280.90	280.85	282.53	
Humidity	2.99	3.02	2.91	3.03	2.88	2.91	2.77	2.97	**2.94**

Flexibility Results Table After 16 Weeks of Cycles V313

FLEXIBILITY TEST – longitudinal sense after 16 weeks of V313						
Test Tube Reference	Side	Thickness in mm	Width in mm	Flex. Resistance	Modulus in MPa	Wrupt in

				in MPa		N.mm
1	Front	15.70	50.37	21.1	3469	4969
2	Front	16.00	50.24	22.2	3551	5303
3	Front	15.74	50.53	22.9	3645	5631
4	Back	15.76	50.32	22.7	3645	5514
5	Back	15.87	50.40	22.7	3648	5613
6	Back	15.81	50.40	22.3	3577	5247
Average				22.3	3591	5380
Standard Deviation				0.7	73	256

CTBA
Sylvadec
Bordeaux 15.05.03
Test report No. F-R /68/02/132/151/2

APPENDIX 3

Density (NF EN 323 of June 1993)						
Test Tube References			Test Tube References	Thickness in mm	Mass in g	Density in Kg/m3
DO1	Length	50.50	DO1	15.71	48.56	1217
	Width	50.29	DO2	15.87	48.89	1217
DO2	Length	50.22	DO3	15.87	49.00	1216
	Width	50.41	DO4	15.92	49.21	1217
DO3	Length	50.53	DO5	15.87	49.21	1220
	Width	50.25	DO6	15.87	49.17	1214
DO4	Length	50.34	DO7	15.83	49.16	1216
	Width	50.47	DO8	15.86	49.19	1214
DO5	Length	50.49	DO9	15.85	49.13	1219
	Width	50.35	DO10	15.86	49.11	1213
DO6	Length	50.50	DO11	15.84	49.21	1216
	Width	50.55	DO12	15.82	49.02	1213
DO7	Length	50.60	DO13	15.88	49.00	1213
	Width	50.55	DO14	15.86	49.12	1217
DO8	Length	50.52	DO15	15.88	49.07	1214
	Width	50.52	DO16	15.70	49.60	1241
DO9	Length	50.55	DO17	15.69	48.62	1215
	Width	50.54	DO18	15.91	49.04	1207
DO10	Length	50.56	DO19	15.74	48.87	1216
	Width	50.52	DO20	15.68	48.53	1215
DO11	Length	50.34				
	Width	50.54	Average	15.81		1217
DO12	Length	50.36	Standard Deviation	0.08		8
	Width	50.56	Max.			1241
DO13	Length	50.43	Min.			
	Width	50.63				
DO14	Length	50.44				
	Width	50.51				
DO15	Length	50.48				
	Width	50.94				
DO16	Length	50.35				
	Width	50.50				

DO17	Length	50.52				
	Width	50.34				
DO18	Length	50.38				
	Width	50.73				
DO19	Length	50.24				
	Width	50.56				
DO20	Length	50.24				
	Width	50.55				