AIMPLAS
INSTITUTO TECNOLÓGICO DEL PLÁSTICO
LABORATORIO DE CONSTRUCCIÓN
CONSTRUCTION LABORATORY

ENAC
ENSAYOS
Nº 56/LE156

REPORT AT-0604/13

NV-13-0626

No OF PAGES: 26

RECEPTION DATE: 26/03/13
STARTING DATE: 16/04/13
FINISHING DATE: 05/06/13

AIMPLAS
N.º S-13-02055
FECHA 11/06/13
REGISTRO DE SALIDA

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OBJECT

Test according DIN 16726 (December 1986).

TESTS

A.- Determination of thickness according DIN 53370 (November 1991). (*)

B.- Determination of tensile properties according to standard DIN 53455 (November 1991) (*)

C.- Resistance to compression according to standard DIN 53454 (April 1971) (*)

D.- Determination of tear resistance according to standard DIN 53363 (May 1969) (*)

E.- Determination of watertightness according to standard DIN 16726 (December 1986) (*)

F.- Determination of peel resistance of joints according to standard UNE in 12316-2 (September 2001)

G.- Determination of dimensional stability according to standard DIN 16726 (December 1986) (*)

H.- Thermal ageing (7 days at 80ºC) DIN 16726 (December 1986) (*)

I.- Determination of water absorption DIN 53495 (April 1984). (*)

J.- Determination of chemical resistance to alkaline or acid substances DIN 16726 (December 1986) (*)

K.- Determination of impact resistance according to standard DIN 16726 (December 1986) (*)

SAMPLES

35041BM3 (S2657401)

- Code: 13/0626/1

TEST PROCEDURES

A.- Thickness

(1) Test:

- Test equipment: electronic comparator.
- Type of measurement surfaces: flat
- Conditioning of specimens: 48 h at (23±2)ºC and (50 ± 5) % RH

(2) Specimens:

- Type of specimens: 100 mm x roll width
- Number of specimens: 1
- No. of measurements: 10 per specimen.

(3) Environment conditions::

T = (23 ± 2) ºC
RH = (50 ± 10) %

B.- Tensile properties

(1) Tests:

- Speed of test: 50 mm/min
- Distance between grips: 120 mm
- Gauge length: 100 mm
- Load cell: 2 kN
- Grips: mechanical
- Class machine (according to ISO 7500):
  - Force: Class 0,5
  - Displacement indicator: Class 0,5
- Extensometer: clamp

(2) Specimen:

- Material: laminated
- Type: type 5 (width 15 mm)
- Preparation: punched
- Dimensions: are indicated in table of results.
- Number of specimens: 5
- Conditioning:

(i) 16 hours at (23 ± 2) ºC and (50 ± 6) % RH
(ii) 7 days at 80ºC
(iii) 28 days in $Ca(OH)_2$ + 7 days at (23±2)ºC and (50±6)%RH according paragraph "J"
(iv) 28 days in H_2SO_3 + 7 days at (23±2)ºC and (50±6)%RH according paragraph "J"
(v) 28 days at 23ºC in NaCl + 7 days at (23±2)ºC and (50±6)%RH according paragraph "J"

(3) Environment conditions:

T = (23 ± 2) ºC
RH = (50 ± 10) %

C.- Compression

(1) Test:

- Speed of test: 1 mm/min
- Distance between grips: 11 mm
- Gauge length: 50 mm
- Load cell: 2 kN
- Class machine (according to ISO 7500):
  - Force: Class 0,5
  - Displacement indicator: Class 0,5
- Extensometer: crosshead
- Compression tool: plates of diameter 135 mm

(2) Specimen:

- Type: diameter 29 mm
- Preparation: punched
- Piling: yes
- Number of samples piled up: 5
- Conditioning: 16 h at (23±2)ºC and (50±5)% RH

(3) Environment conditions:

T = (23±2) ºC
RH = (50±10) %

D.- Tear resistance

(1) Test:

- Test speed: 100 mm/min
- Distance between grips: 52,5 mm
- Load cell: 10 kN
- Grips: pneumatic
- Class machine (according to ISO 7500):
  - Force: Class 0,5
  - Displacement indicator: Class 0,5
- Extensometer: crosshead

(2) Specimens:

- Material: sheet
- Type: figure 1 DIN 53363
- Preparation: handmade
- Dimensions: are indicated in table of results.
- Number of specimens: 5
- Conditioning: 24 hours at (23 ± 2) ºC and (50 ± 6) % RH

(3) Environment conditions:

T = (23 ± 2) ºC
RH = (50 ± 10) %

E.- Watertightness

(1) Test/s:

- Method: B
- Immersion time: 10 hours
- Test pressure: 10 bar
- Face of applying pressure: external

(2) Specimen/s:

- Number of specimens: 3
- Type: Ø 130 mm
- Conditioning: 24 hours at (23±2)ºC and (50±6)% RH

(3) Environment conditions:

-T = (23 ± 2) ºC
-RH = (50 ± 10) %

F.- Welding resistance.

(1) Test:

- Speed of test: 100 mm/min
- Distance of the grips: 100 mm
- Load cell: 50 kN
- Grips: mechanical
- Class machine (according to ISO 7500):
  - Force: Class 0,5
  - Displacement indicator: Class 1
- Extensometer: crosshead

(2) Specimens:

- Test specimen: width 50 mm
- Preparation of the specimen: handmade
- Dimensions: are indicated in tables of results
- Number of specimens: 5
- Conditioning: 20 hours at (23 ± 2) ºC and (50 ± 20) % RH

(3) Environment conditions:

T = (23 ± 2) ºC
RH = (50 ± 10) %

G.- Dimensional stability.

(1) Tests:

- Standard: DIN 53377 (May 1969)
- Conditioning:

  - Conditioning (ii) *according paragraph "H": 7 days at 80ºC.*
  - (vi) 6 hours at 80ºC

- Equipment: air circulating oven
- Test duration: 24 hours
- Post conditioning: 30 minutes at (23±2)ºC and (50±10)% RH

(2) Specimens:

- Type: (100x100) mm
- Nº samples: 3

(3) Environment conditions:

T = (23 ± 2) ºC
RH = (50 ± 10) %

H.- Heat Ageing (7 days at 80ºC)

(1) Test:

- Standard: DIN 16726 (December 1986)
- Conditioning type: 7 days at 80ºC
- Equipment: air circulating oven
- Test duration: 7 days
- Post conditioning: 7 days at (23±2)ºC and (50±6)% RH

(2) Specimens:

- Type: (100x100) mm
- Nº samples: 5 for each direction

(3) Environment conditions:

T = (23 ± 2) ºC
RH = (50 ± 10) %

I.- Water absorption

(1) Tests:

- Standard: DIN 53495 (April 1984)
- Method: 24h at 23ºC
- Equipment: air circulating oven

(2) Specimens:

- Type: (50x50) mm
- Nº of samples: 3
- Conditioning: 24 hours at 50ºC

(3) Environment conditions:

T = (23 ± 2) ºC
RH = (50 ± 10) %

J.- Chemical resistance

(1) Tests:

- Standard: DIN 16726 (December 1986)
- Methods:

(iii) 28 days in $Ca(OH)_2$ + 7 days at (23±2)ºC and (50±6)%RH
(iv) 28 days in disolución 6% de H_2SO_3 + 7 days at (23±2)ºC and (50±6)%RH
(v) 28 days at 23ºC saturated solution of NaCl + 7 days at (23±2)ºC and (50±6)%RH

(2) Specimens:

- Nº of samples: 5 each direction
- Post conditioning: 7 days at 50ºC (23±2)ºC and (50±6)% RH

(3) Environment conditions:

T = (23 ± 2) ºC
RH = (50 ± 10) %

K.- Impact resistance

(1) Test:

- Mass (without aditional masses): 502,4 g
- Pressure applied to the detection of puncturing: 15 kPa

(2) Specimens:

- Average thickness: 2,15 mm
- Equipment: mechanical comparator
- Conditioning: 24h at (23±2)ºC and (50±6)% RH

(3) Environment conditions:

T = (23 ± 2) ºC
RH = (50 ± 6) %

RESULTS

A.- Thickness

Table 1

Specimen	Thickness (mm)
1	2,12
2	2,14
3	2,13
4	2,17
5	2,15
6	2,14
7	2,16
8	2,16
9	2,16
10	2,15
Average Standard deviation	2,15 0,02

Note 1: 10 measurements have been realized in each specimen, the average value is shown in the table.

B.- Tensile properties

(i) 16 hours at (23 ± 2) ºC and (50 ± 6) % RH

Lengthwise

Table 2

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,15	15,070	15,9	270
2	2,16	15,070	15,9	280
3	2,12	15,070	15,9	270
4	2,14	15,070	16,2	280
5	2,11	15,070	15,9	270
Average Uncertainty (k=2)			16,0 ±0,2	280 ±7

Transverse

Table 3

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,14	15,066	15,7	270
2	2,11	15,066	16,0	270
3	2,12	15,066	16,0	280
4	2,14	15,066	15,8	270
5	2,11	15,066	16,0	270
Average Uncertainty (k=2)			16,0 ±0,2	270 ±5

(ii) 7 days at 80°C according paragraph H

Lengthwise

Table 4

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,09	15,035	15,6	280
2	2,10	15,035	15,8	280
3	2,09	15,035	15,3	270
4	2,11	15,035	16,4	280
5	2,09	15,035	15,4	270
Average Uncertainty (k=2)			15,4 ±0,3	280 ±7

Transverse

Table 5

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,10	15,070	15,4	280
2	2,06	15,070	14,6	250
3	2,08	15,070	15,6	280
4	2,08	15,070	15,6	270
5	2,10	15,070	14,9	260
Average Uncertainty (k=2)			15,2 ±0,5	270 ±10

(iii) 28 days in $Ca(OH)_2$ + 7 days at (23±2)°C and (50±6)%RH

Lengthwise

Table 6

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,08	15,080	15,9	280
2	2,09	15,080	15,7	280
3	2,09	15,080	15,8	270
4	2,10	15,080	16,8	280
5	2,08	15,080	15,5	270
Average Uncertainty (k=2)			15,7 ±0,2	280 ±4

Transverse

Table 7

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,11	14,931	14,1	280
2	2,10	14,931	14,3	280
3	2,10	14,931	14,0	270
4	2,11	14,931	14,8	290
5	2,09	14,931	14,6	290
Average Uncertainty (k=2)			14,4 ±0,3	280 ±8

(iv) 28 days in H_2SO_3 + 7 days at (23±2)°C and (50±6)%RH

Lengthwise

Table 8

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,19	16,198	13,4	250
2	2,21	16,198	13,0	240
3	2,19	16,198	14,0	260
4	2,19	16,198	13,3	240
5	2,19	16,198	14,0	250
Average Uncertainty (k=2)			13,6 ±0,5	250 ±9

Transverse

Table 9

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,20	16,121	13,0	260
2	2,21	16,121	12,9	250
3	2,21	16,121	13,0	250
4	2,20	16,121	13,2	270
5	2,21	16,121	13,4	270
Average Uncertainty (k=2)			13,1 ±0,2	260 ±7

(v) 28 days at 23ºC in NaCl + 7 days at (23±2)ºC and (50±6)%RH

Lengthwise

Table 10

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,09	15,032	16,0	270
2	2,08	15,032	15,9	280
3	2,08	15,032	16,0	280
4	2,07	15,032	16,5	290
5	2,08	15,032	16,4	290
Average Uncertainty (k=2)			16,2 ±0,3	280 ±8

Transverse

Table 11

Test	Thickness (mm)	Width (mm)	Tensile strength (MPa)	Elongation at break (%)
1	2,10	14,920	14,4	280
2	2,09	14,920	14,8	290
3	2,08	14,920	15,0	300
4	2,09	14,920	14,5	280
5	2,09	14,920	14,9	290
Average Uncertainty (k=2)			14,7 ±0,3	290 ±8

C.- Compression

Table 12

Test	Thickness (mm)	Fuerza al 20% (N/mm^2)
1	28,73	4,83
2	28,61	4,80
3	28,57	4,78
4	28,63	4,70
5	28,67	4,76
Average Standard deviation		4,77 0,05

Nota 2: Force-displacement graph is shown in the Annex II.

D.- Tear resistance

Lengthwise

Table 13

Test	Thickness (mm)	Tear resistance (N/mm)
1	2,150	121,3
2	2,120	119,3
3	2,140	121,4
4	2,140	129,6
5	2,130	112,3
Average Uncertainty (k=2)		120,8 ±6

Transverse

Table 14

Test	Thickness (mm)	Tear resistance (N/mm)
1	2,100	117,1
2	2,110	109,1
3	2,110	109,4
4	2,110	118,8
5	2,110	116,6
Average Uncertainty (k=2)		114,2 ±5

Nota 3: Force-displacement graph is shown in the Annex II.

E.- Watertightness

Table 15

Test	Thickness (mm)	Result
1	2,13	OK
2	2,15	
3	2,13	

F.- Peel resistance of joints

Table 16

Test	Thickness (mm)	Width (mm)	Tensile strength (N)	Tensile strength (N/50mm)	Remarks
1	2,15	49,73	531	534	Sheet failure (no joint break)
2	2,15	50,43	559	554	
3	2,16	49,98	536	536	
4	2,11	50,27	579	576	
5	2,17	49,72	521	524	
Average Uncertainty (k=2)			545 ±19	545 ±19	

Nota 4: Force-displacement graph is shown in the Annex II.

G.- Dimensional stability.

(vi) 6 hours at 80ºC

Table 17

Specimen	Initial measurements (mm)		Final measurements (mm)		Lengthwise variation (%)	Transverse variation (%)
	Lengthwise (Lo)	Transverse (To)	Lengthwise (Lt)	Transverse (Tt)		
1	100,40	100,30	99,15	100,40	-1,25	0,10
2	100,30	99,88	99,20	100,20	-1,10	0,22
3	100,15	99,43	98,91	99,64	-1,23	0,21
				Average	-1,19	0,17
				Standard deviation	0,08	0,07

(vi) 7 days at 80°C

Table 18

Specimen	Initial measurements (mm)		Final measurements (mm)		Lengthwise variation (%)	Transverse variation (%)
	Lengthwise (Lo)	Transverse (To)	Lengthwise (Lt)	Transverse (Tt)		
1	100,05	99,42	98,64	99,47	-1,41	0,05
2	100,38	99,45	98,95	99,51	-1,42	0,06
3	99,63	99,31	98,37	99,36	-1,26	0,06
				Average	-1,36	0,06
				Standard deviation	0,09	0,01

H.- Heat ageing (7 days at 80°C)

- Conditioning: 7 days at 80°C in oven + 72 hours at (23±2)°C and (50±6)% RH

Appearance:

Table 19

Test	Visual assessment	
	Zoom: 1x	Zomm: loupe 8x
Heat ageing 7 days at 80°C	No color or gloss changes, blistering or cracks are observed.	No color or gloss changes, blistering or cracks are observed.

Dimensional variation

Table 20

Specimen	Lengthwise variation (%)	Transverse variation (%)
Average	-1,36	0,06
Standard deviation	0,09	0,01

Tensile properties

Table 21

Test	Tensile strength (MPa)		Elongation at break (%)	
	Lengthwise	Transverse	Lengthwise	Transverse
Control specimens	15,9	15,9	277,7	271,0
Exposed specimens	15,5	15,4	276,5	267,7
Variation (%)	2,5	2,9	0,4	1,2

Foldability at low temperatures

- Specimens: (100 x 50) mm
- N° of specimens: 4 (2 in each direction)

Table 22

Specimen	Thickness (mm)	Minimum temperature reached without cracks (°C)	Result
1	2,10	-20°C	No break
2	2,10	-20°C	No break
3	2,12	-20°C	No break
4	2,13	-20°C	No break

I.- Water absorption

Table 23

Specimen	Initial mass (g) (m_i)	Final mass (g) (m_f)	Absorbed mass (%)
1	6,8795	6,8901	0,15
2	6,9221	6,9315	0,14
3	6,9340	6,9445	0,15
		Average	0,15
		Standard deviation	0,01

J.- Chemical resistance

(iii) 28 days in $Ca(OH)_2$ + 7 days at (23±2)°C and (50±6)%RH

Tensile properties (L and T)

Table 24

Test	Tensile strength (MPa)		Elongation at break (%)	
	Lengthwise	Transverse	Lengthwise	Transverse
Control specimens	15,9	15,9	277,7	271,0
Exposed specimens	15,7	14,4	276,2	278,6
Variation (%)	1,3	9,8	0,5	-2,8

Foldability at low temperatures

- Specimens: (100 x 50) mm
- Nº of Specimens: 4 (2 in each direction)

Table 25

Specimen	Thickness (mm)	Minimum temperature reached without cracks (°C)	Result
1	2,09	-20°C	No break
2	2,11	-20°C	No break
3	2,11	-20°C	No break
4	2,09	-20°C	No break

(iv) 28 days in H_2SO_3 + 7 days at (23±2)°C and (50±6)%RH

Tensile properties

Table 26

Test	Tensile strength (MPa)		Elongation at break (%)	
	Lengthwise	Transverse	Lengthwise	Transverse
Control specimens	15,9	15,9	277,7	271,0
Exposed specimens	13,6	13,1	247,8	261,7
Variation (%)	14,9	17,7	10,8	3,4

Foldability at low temperatures

- Specimens: (100 x 50) mm
- Nº de Specimens: 4 (2 in each direction)

Table 27

Specimen	Thickness (mm)	Minimum temperature reached without cracks (°C)	Result
1	2,09	-20°C	No break
2	2,11	-20°C	No break
3	2,11	-20°C	No break
4	2,09	-20°C	No break

(v) 28 days at 23ºC in 10% de NaCl + 7 days at (23±2)ºC and (50±6)%RH

Tensile properties

Table 28

Test	Tensile strength (MPa)		Elongation at break (%)	
	Lengthwise	Transverse	Lengthwise	Transverse
Control specimens	15,9	15,9	277,7	271,0
Exposed specimens	16,2	14,7	280,6	286,3
Variation (%)	-1,5	7,4	-1,0	-5,6

Foldability at low temperatures

- Specimens: (100 x 50) mm
- Nº de Specimens: 4 (2 in each direction)

Table 29

Specimen	Thickness (mm)	Minimum temperature reached without cracks (ºC)	Result
1	2,09	-20ºC	No break
2	2,11	-20ºC	No break
3	2,11	-20ºC	No break
4	2,09	-20ºC	No break

K.- Impact resistance

Table 30

Test		Requirement (mm)	Highest point without punching (mm)	Remarks
Specimen	Thickness (mm)			
1	2,15	750mm	750mm	No break
2	2,17		750mm	No break
3	2,13		750mm	No break
4	2,14		750mm	No break
5	2,14		750mm	No break

ANNEX I

TABLE 1 SUMMARY

TEST				Requirement	Result	Conformity
Description		**Standard**	**units**			
Thickness		DIN 53370	mm	>2,0	2,15 0,02	**OK**
Tensile properties	Tensile strength	DIN 53455	N/mm^2	>15	16,0 ±0,2	**OK**
	Elongation at break		%	>250	278 ±7	**OK**
Compression		DIN 53454	N/mm^2	>2,5	4,78 0,47	**OK**
Tear resistance		DIN 53363	N/mm	>100	121 ±6	**OK**
Watertightness		DIN 16726	-	Waterproof at 10 bar	Waterproof at 10 bar	**OK**
Peel resistance of joints		UNE EN 12316-2	N/mm	-	545 ±19	-
			N/50mm	-	545 ±19	-
Dimensional stability (6h at 80ºC)		DIN 16726	%	<±2	Lengthwise -1,19 Transverse 0,17	**OK**
Heat ageing (7 days at 80ºC)	appearance	DIN 16726	-	No blisters	No blisters	**OK**
	Dimensional stability		-	-	Lengthwise -1,36	-
			-	-	Transverse 0,06	-
	Tensile strength variation		%	<-3	2,5 (L) 2,9 (T)	**OK**
	Elongation at break variation		%	<±10	0,4 (L) 1,2 (T)	**OK**
	Foldability at low temperatures		%	<±10	No break at -20ºC	**OK**
Water absorption		DIN 53495	%	<1	0,15	**OK**

TABLE 2 RESULTS

TEST					Requirement	Result	Conformity
description			standard	units			
Chemical resistance	$Ca(OH)_2$	Tensile strength variation	DIN 16726	%	<±20	1,3 (L) 9,8 (T)	OK
		Elongation at break variation		%		0,5 (L) -2,8 (T)	OK
		Foldability at low temperatures		-	no cracks	no cracks	OK
	H_2SO_3	Tensile strength variation		%	<±20	14,9 (L) 17,7 (T)	OK
		Elongation at break variation		%		10,8 (L) 3,4 (T)	OK
		Foldability at low temperatures		-	no cracks	no cracks	OK
	$NaCl$	Tensile strength variation		%	<±20	-1,5 (L) 7,4 (T)	OK
		Elongation at break variation		%		-1,0 (L) -5,6 (T)	OK
		Foldability at low temperatures		-	no cracks	no cracks	OK
Puncturing resistance DIN 50014			DIN 50014	-	no puncturing at 750 mm	no puncturing at 750 mm	OK

ANNEX II

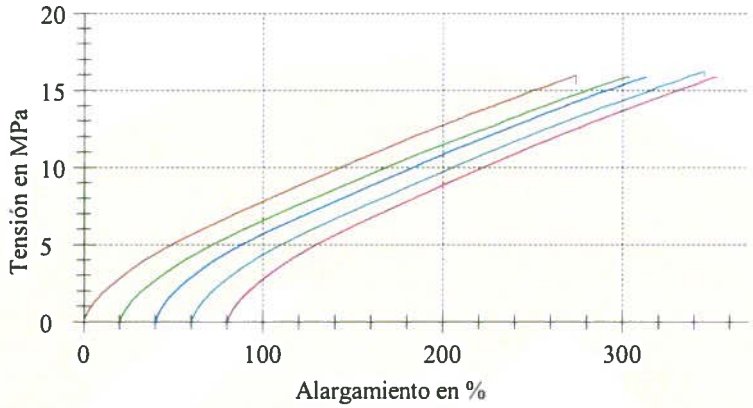

Fig 1.- Stress-strain graph of tensile test after 16 hours at (23±2)ºC; (50±6)%RH

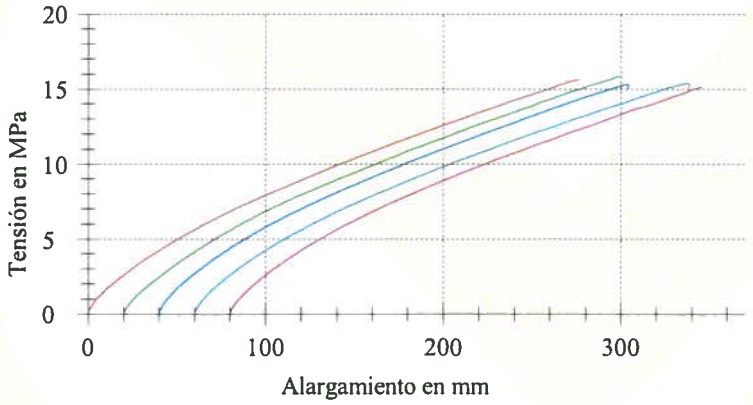

Fig 2.- Stress-strain graph of tensile test after
7 days at 80ºC + 72hours at (23±2)ºC; (50±6)%RH

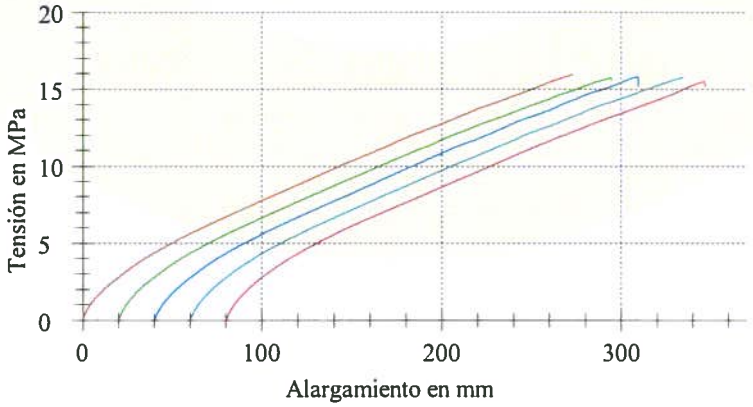

Fig 3.- Stress-strain graph of tensile test after
28 days at 23ºC in $Ca(OH)_2$ + 7 days at (23±2)ºC; (50±6)%RH

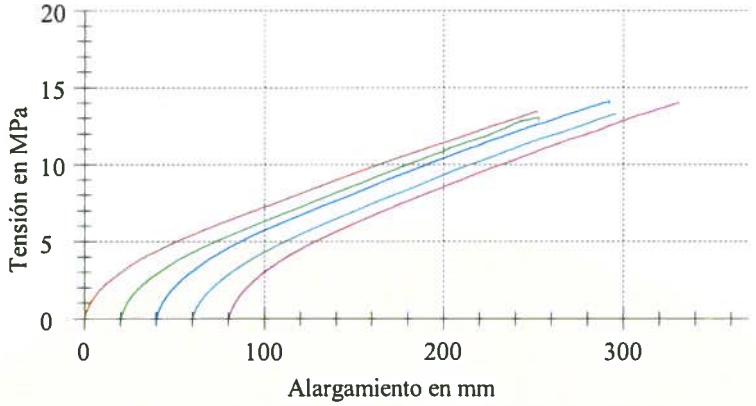

Fig 4.- Stress-strain graph of tensile test after
28 days at 23ºC in H_2SO_3 + 7 days at (23±2)ºC; (50±6)%RH

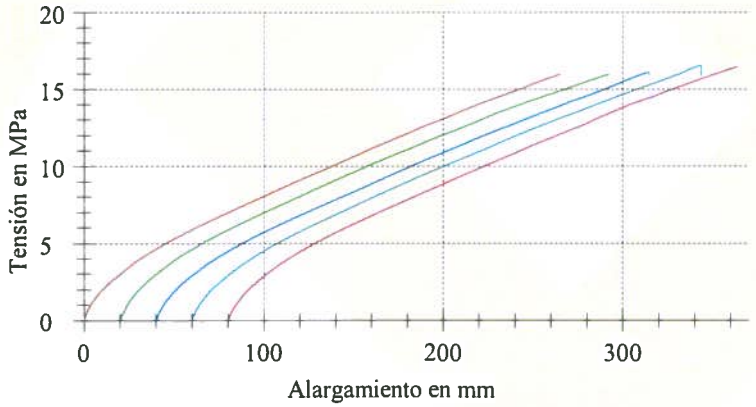

Fig 5.- Stress-strain graph of tensile test after
28 days at 23ºC in NaCl + 7 days at (23±2)ºC; (50±6)%RH

Fig 6.- Stress-strain graph of compression test after
16 hours at (23±2)ºC ; (50±5)%RH

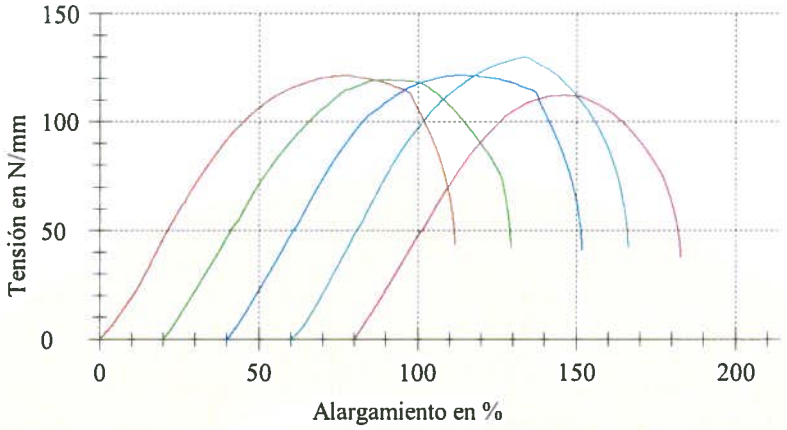

Fig 7.- Stress-strain graph of peel resistance of joints test after 24 hours at (23±2)°C; (50±6)%RH

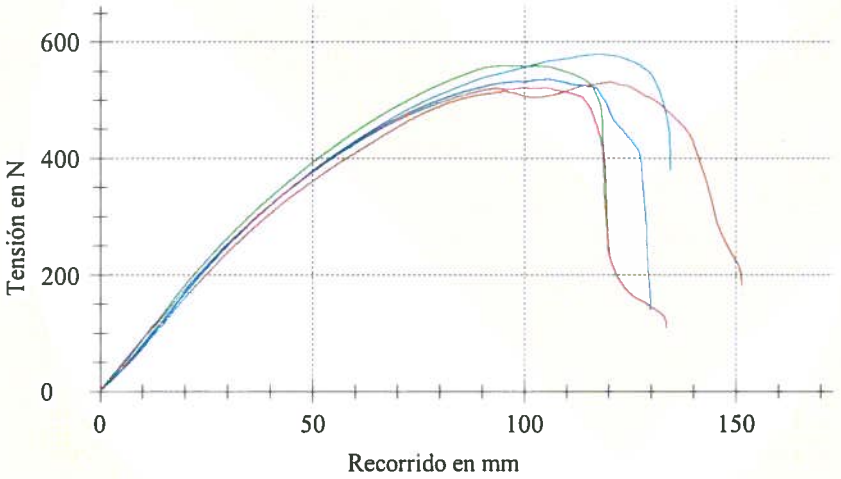

Fig 8.- Stress-strain graph of peel resistance of joints test after 20 hours at (23±2)°C; (50±20)%RH

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