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mechanical tests of Structural Panels

Applicant: PROPANELES SAS

CTM Report 21/104

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IRAM 11596- IRAM 11595	IRAM 11588- IRAM 11585
Applicant: PROPANELES SAS	louis perata

1. Service performed

The objective of this work is to test structural panels in order to evaluate them in its structural behavior under conditions that represent its performance in service.

For this purpose, the requirements of IRAM 11596 Standards are applied; test method Soft Impact on Vertical Test Specimens, IRAM 11595 Standard; Manufactured Panels for Walls of Buildings. Steel Ball Impact Resistance Test Method; IRAM 11588 standard; Blind Walls of Buildings. Compression Test Method, and IRAM 11585 Standard; panels for Walls and Partitions of Buildings.

This report analyzes, under the standards mentioned, panels supplied by the supplier in order to evaluate and obtain mechanical characteristics of the panels that may be used in the resistant design of houses built by this method.

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2. Experimental details

2.1. Sample Characteristics

Constructive description of the panels

The following description of the internal constitution of the panels and property data mechanical characteristics of its materials, were provided by the manufacturer.

2.1. 1.Material:

2. Construction description of the panels

The following description of the internal constitution of the panels and property data mechanical characteristics of its materials, were provided by the manufacturer.

2.1-General Description

"Propanel MGO SIP" are structural thermal panels, composed of a polystyrene core expanded (EPS) of high density (15 kg/m3) and two plates MGO sulfate magnesium oxide. The manufacturing consists of joining these elements by means of pressure and with adhesives applied in a controlled environment, making the elements work together, delivering a high mechanical and thermal resistance.

This product is designed to be used primarily in structural walls of 1 or 2 story homes, additions, commercial buildings, and as part of the roofing solution.

2.2- Format and assembly

The standard format of the panel is 1.22 x 2.44 Mts. The thickness can vary according to the need project the panels can be from 90 mm to 200 mm varying the thickness of the boards and the EPS core.

Fire classification: - Self-extinguishing, standard ASTM D 4986 - 95

- Hardly flammable (Group B1) DIN 4102 standard

- Group 94 HF 1 standard UL 94 Underwriter Laboratories Inc.(USA)

For 110mm "Propanel MGO SIP" (10mm magnesium sulfate oxide MGO plates – EPS 90 mm – magnesium sulphate oxide MGO plates 10mm), it is recommended to use in screeds of starting and finishing pieces of plywood 35mm x 87mm. For meetings of walls and corners, pieces of plywood 45mm x 87mm.

Before beginning the installation of walls, the thickness of the panels must be traced on the platform or floor structure, fix the plinth/piece of plywood 35mm x 87mm every 40cm. The The "Propanel MGO SIP" panel must be completely supported on the lower sill. in slabs of incorporate between this and the plywood floor a lifting cord of concrete pavers.

The "Propanel MGO SIP" panels are installed vertically on the wooden floor, recommends starting at a corner incorporating a piece of plywood dimensioned 35mm x 87mm inside the panel (see figure 2).

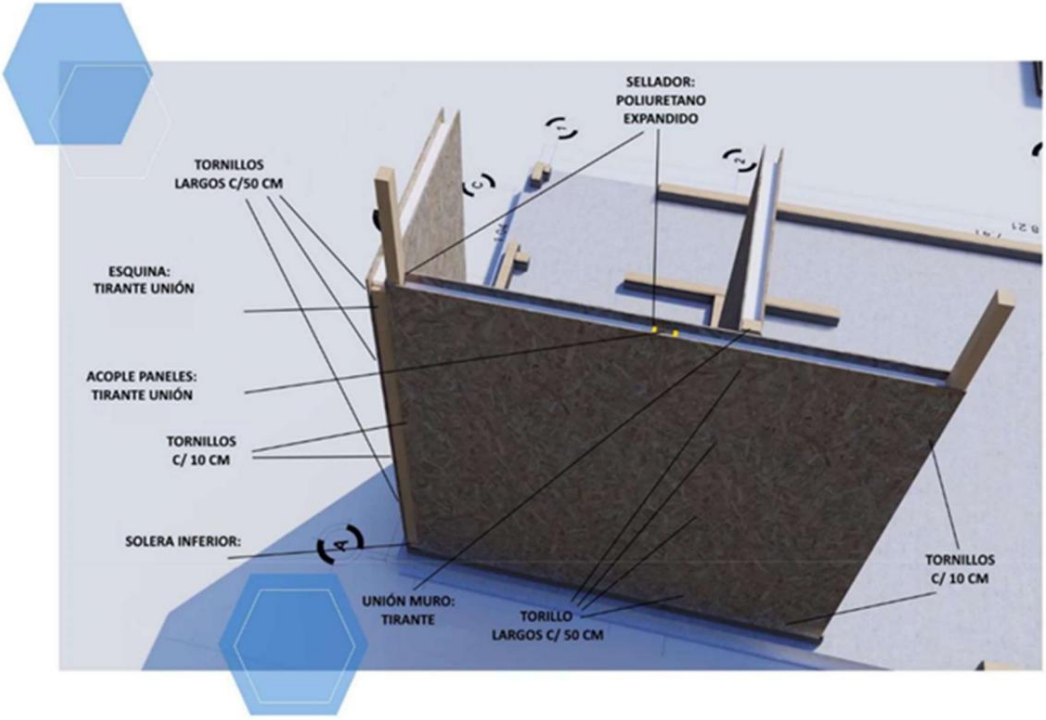


Figure Nº 2: Scheme of corner union and vertical connection between panels.

Another corner panel is installed at a 90° angle. Then the union is fixed with 6mm x 160mm wood screws every 40cm. Then proceed to install the panels that make up the wall, which are joined together by means of a 35mm piece of plywood x 87mm. (see figure 2).

The linkages of the panels in upper/lower slabs and vertical joints are must be made with 6mm x 1 1/2" Tel Fix screws, 1 cm from the edge and every 10 cm throughout the perimeter. Correct installation will avoid structural continuity problems.

Once the panels have been installed, the upper slab is placed, which links the entire set. The floor joint must not coincide with a panel joint, the joints being overlapped. joints minimum 30 cm. Before installing the screed, polyurethane adhesive or sealant must be applied, then the panels are fixed to the floor every 10 cm (see figure 2).

3. Results.

In common agreement with the applicant, it was decided to develop the following tests:

3.1. IRAM 11596 standards; Soft Impact Test Method on Specimens Verticals

For this test, a leather bag with sand inside is used. Weight: 30 kgf. is left drop the bag from increasing heights with a pendulum motion.

Depending on the height from which the bag is dropped, a certain energy is generated of impact. Instantaneous deflections and residual deflections are then measured and deterioration observed. that occurs on the outer skin of the panel.

The instantaneous deflection is the one that is measured under load and the residual or permanent deflection is the one that It is measured after the load has been removed.

3.1.1. Dashboard Description

Three samples of an external (structural) wall panel are tested Composition: MGO plates magnesium sulfate oxide 10 mm + EPS 90 mm + magnesium sulfate oxide MGO plates 10 mm, corresponding to a module of 1.22 m wide x 2.44 m high x 110 mm thick and nominal weight of 75 Kg. The samples were delivered by the client to our Laboratory ready for testing. The The panel assembly process was not supervised by CECITEMA.

3.1.2. Assembly and instrumentation

The panel is simply assembled supported on a reaction structure arranged in a vertical, with a span between supports of 2.0 m. The assembly of the panel is materialized by means of of a series of steel tubes placed on the edges of the panel and a set of metal clamps (See photo of Figure No. 2).

To apply the impact, a canvas bag filled with sand is used, with a total mass of 30 kg. This bag is fixed to the structure, at a point located on the panel, so that the impact is applied to the center of the panel, perpendicular to its plane (Scheme of Figure No. 6).

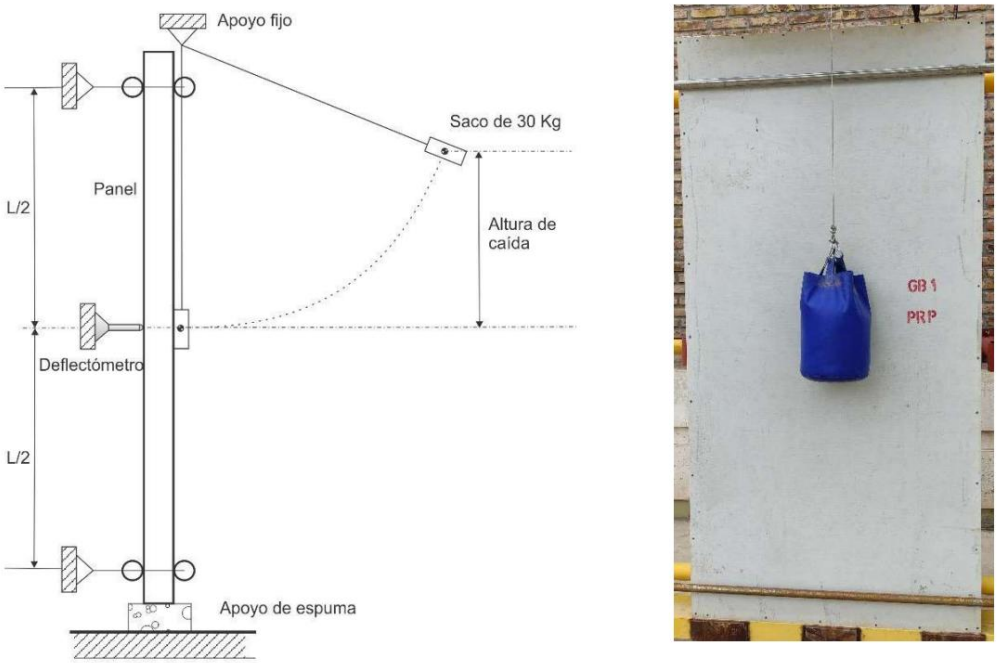


Figure Nº 6: Scheme of the test and photo of the test process

The instrumentation used is defined according to what is specified in the IRAM 11596 standard. A deflectometer is used as shown in the photo of Figure Nº 7, to measure the deformations instantaneous and residual out-of-plane of the panel at the point of impact. The deflectometer is located on the axis center of the rear face of the panel, at the height of the impact application.

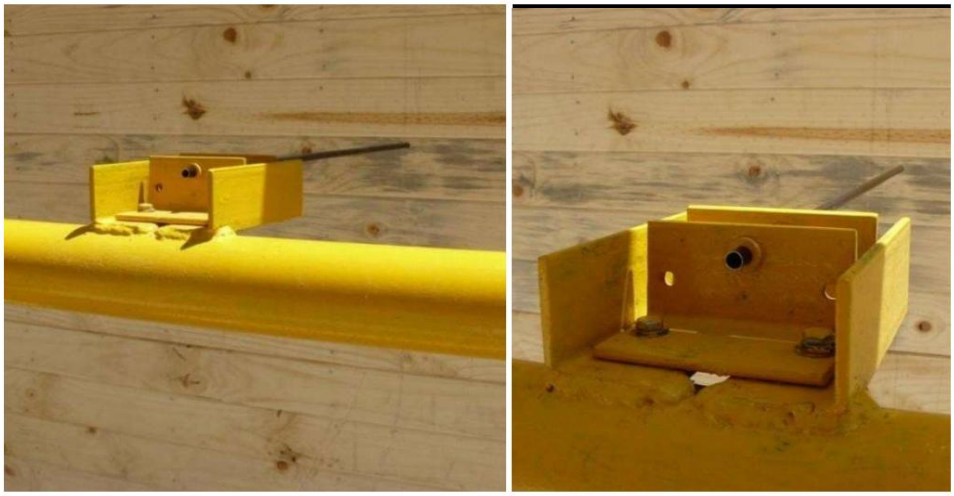


Figure Nº 7: Photo of the deflectometer and detail.

3.1.3. Test Procedure

The test procedure basically consists of:

_ Fix the panel to the reaction structure and place the instrumentation.

_ Impacts are then applied to the panel, increasing the drop height to 45 cm, 60 cm and 120 cm until breaking, or a maximum impact energy of 360 Joules. At each impact, the instantaneous and residual deflections of the panel on the rear face are measured, as well as the deformation residual or permanent on the face of impact (at the point of impact).

_ At the end of the test, the local damage and the final state of the panel are observed.

3.1.4. Results

In Table 1, the following test results are indicated: a) first visible damage to simple view on the panel; and b) the residual deflection for the outer face of the panel for different levels of impact energy.

The samples tested meet the acceptance criteria for the impact test soft, which are:

a) for an energy of 135 joules with a drop height of 45 cm, the panel does not have an arrow residual greater than 0.2% of the height of the wall tested (0.44 cm), and is not greater than 0.5 cm.

b) for an energy of 180 joules with a drop height of 60 cm, the panel does not suffer visible deterioration; and for an energy of 360 joules with a drop height of the bag at 120 cm from the panel must not pass through the bag or be damaged in such a way as to compromise the safety of the building occupants.

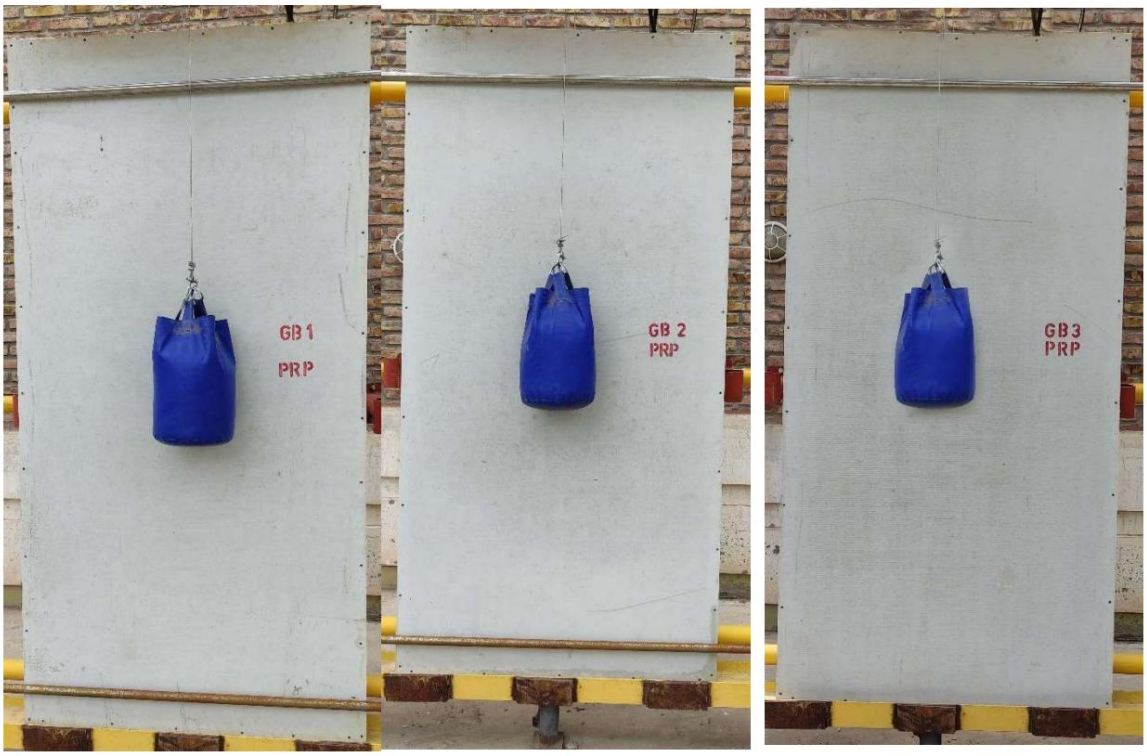
The results presented in the report are only valid for the samples identified in it, and cannot be referred to batches or batches.

c) Table I is presented, to the composition panels: MGO magnesium sulfate oxide plates 10 mm + EPS 90 mm + magnesium sulfate oxide MGO plates 10 mm.

TABLE I. PANEL: magnesium sulfate oxide MGO plates + EPS 90 mm + magnesium sulfate oxide MGO plates

No.	Height test tube cm	Weight kg	Impact Height (cm)	Impact Energy (J)	Arrow Snapshot hmm	Arrow permanent hmm	Observations
1	243	75	Four. Five	135	16	1	The panel shows no apparent damage throughout the test.
			60	180	30	1	
			120	360	36	two	
two	243	74	Four. Five	135	16	1	The panel is not damaged apparent throughout the trial.
			60	180	23	1	
			120	360	30	1	
3	244	78	Four. Five	135	16	1	The panel is not damaged apparent throughout the trial
			60	180	18	1.5	
			120	360	29	two	

Note: Although the instantaneous deflection is not considered in the acceptance criteria of the applied standard, its determination can be used to verify the performance conditions of the wall, when it is a regulatory requirement for this typology.



3.2. IRAM 11595 standards; Steel Ball Impact Strength Test Method

For this test a 5 cm steel ball is used. diameter. The ball is dropped from increasing heights (staggered every 25 by 25 cm.) up to a maximum height of 2 m. It is done on the outer lining. Again, depending on the height, a certain energy of impact. The diameters of the imprints (marks) and the depth of the imprints are then measured.

3.2.1. Test Procedure

For each drop height, the damages on the face and back of the fall are observed and recorded. specimen, when there is one, the diameter and depth of the imprint produced by the ball are noted steel on the surface of the specimen.

3.2.2. Results

The samples tested meet the acceptance criteria for the soft impact test, which are:

a) For a fall height of 50 cm, it will present a diameter of the footprint left by the ball, less than or equal to 20 mm

b) For a drop height of 75 cm, there will be no change in the rest of the surface of the sample being tested,

c) For a height of fall not greater than 2 m, it will not be crossed by the steel ball

The results presented in Tables III are only valid for the samples identified in it, and cannot be referred to batches or lots.

Figure Nº 8 graphically represents the values of the boards.

Table III: PANEL: Composition of magnesium sulfate oxide MGO plates + EPS 90 mm + magnesium sulfate oxide MGO plates

Sample	Imprint diameter (1)							
	25cm	50cm	75cm	100cm	125cm	150cm	175cm	200cm
01	0	17	[illegible]	29	32	36	39	43
02	0	17	19	30	3. 4	37	41	[illegible]
03	0	18	[illegible]	29	33	37	42	44

(1) The values in the table correspond to the diameter of the imprint of the steel ball

Figure Nº 8: Graphical representation of the Steel Ball Impact Resistance Test Method and photography of its imprints

3.3. IRAM 11585 standards; Eccentric Vertical Load Test Method

Two metal brackets are placed on the internal lining of the panel, which are fixed with screws to the center vertical studs of the panel. A load of 50 daN is applied to each of the brackets for 24 hours.

3.3.1. Test Procedure

A minimum of three panels are tested in accordance to the following scheme of figure Nº 9 and it is kept charged for 24 hours. The device is fixed in the area considered less resistant. In our case they loaded at the center point of the panel. A charge is allowed to act 100 daN parallel to the panel located at 30 cm and transmitted with two brackets with two fixings 15 cm apart. The panel behavior will be considered satisfactory if no no visible damage or deformation

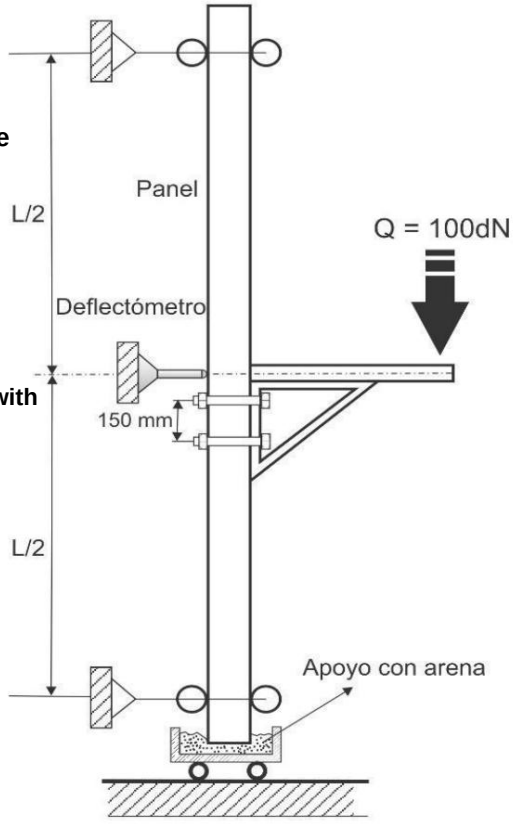


Figure Nº9: Eccentric vertical load test scheme.

3.3.2. Results

Table IV shows the results of the trial. The samples tested meet the acceptance criteria for the Loads test. eccentric verticals according to table IV;

Table IV: PANEL magnesium sulfate oxide MGO plates + EPS 90 mm + magnesium sulfate oxide MGO plates

No.	Height test tube cm	Width test tube cm	Thickness cm	Weight Kg	Impact Height (cm)	Impact Energy (J)	Arrow Snapshot hmm	permanent arrow hmm	Observations
1	243	121.6	eleven	75	Four. Five	135	16	1	No permanent deformation observed
					60	180	30	1	
					120	360	36	two	
two	243	121.6	10.7	74	Four. Five	135	16	1	There is no permanent damage
					60	180	23	1	
					120	360	30	1	
3	243.5	122.2	eleven	78	Four. Five	135	16	1	There is no permanent damage
					60	180	18	1.5	
					120	360	29	1.6	

Note: Although the instantaneous deflection is not considered in the acceptance criteria of the applied standard, its determination can be used to verify the performance conditions of the wall, when it is a regulatory requirement for this typology.

Figure Nº 10: Photos of the eccentric load tests

The results presented in the report are only valid for the samples identified in it, and cannot be referred to batches or batches.

3.4. IRAM 11588 standards; Compression Test Method

In this test, the Panel is subjected to a stepped compression load. Your goal is determine the deformations suffered by the Panel. Compressometers and deflectometers are used for to quantify the deformations and deflections produced during the test.

Thus, the load-shortening and load-lateral values, instantaneous and permanent, and the breaking load.

3.4.1. Test Procedure

At least three panels are tested according to the following scheme in figure Nº 5. This The test consists of subjecting a module isolated from the panel, placed in a vertical position and simply supported at its upper and lower ends, to the action of an applied vertical load. The load of compression is applied incrementally and quasi-statically, through load-unload cycles. During The test measures the longitudinal deformation and the transverse deflection of the panel under maximum load and when downloading.

3.4.2. Assembly and Instrumentation

The panel is mounted vertically, supporting it between the plates of the Testing Machine. The distribution of the load on the support faces of the panel is materialized by means of a load frame of steel that cover the entire length of the support face of the panel. Figure No. 11

Figure Nº11: General view of the compression test.

The instrumentation used is adapted according to what is specified in the IRAM 11588 Standard. Four displacement transducers built with 4 potentiometers are used to measure the longitudinal deformation of the panel digitally, two displacement transducers to measure the central deflection at half height of the LVDT type panel and a load cell of 300

Figure Nº 8: a) Details of the potentiometer to measure the longitudinal deformation of the panel. b) Detail of the instruments to measure the central deflection. c) Detail of the load cell

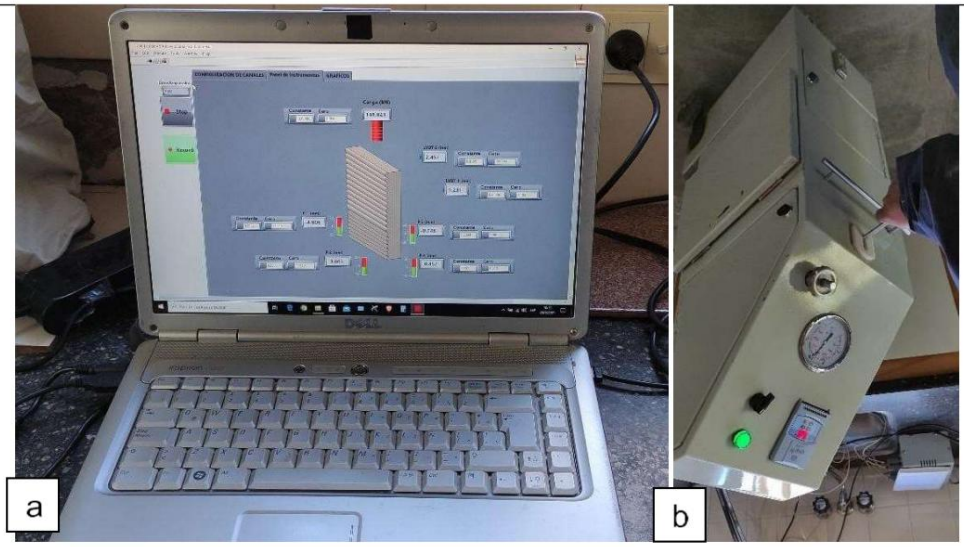


Figure Nº 12: a) Software screen acquiring and indicating the values of each instrument.

b) Hydraulic cylinder command

3.4.3. Test Procedure

The test procedure basically consists of:

1) Fix the panel on the Compression Machine and place the instrumentation.

2) Next, the load and deformation data of the panel are acquired through a software forming a txt file (Figure Nº 12). The load is applied incrementally, by cycles of load – unload, progressively increasing the maximum applied load. The load increase is approximately 20 KN and the length to measure the deformation is L= 2010 mm. In every cycle of load, the axial deformation and transverse central deflection of the panel are measured under maximum load and at unload the panel by measuring the permanent deformation.

3) At the end of the test, the failure mode of the panel and the local damages presented are observed.

In Table VI, the results of the test are indicated. The tested samples comply with the acceptance criteria for the test Vertical loads.

The calculation of the arithmetic mean (Prm) of the breaking loads (Pri) is carried out using the following formula:

$$Prm = \ddot{y} Pri / n$$

Where: n is the number of panels in The standard deviation (S) is:

$$S = [\ \ddot{y} (Pri - Prm)2 / (n-1)]^{1/2}$$

The coefficient of variation ÿ results;

$$\ddot{y} = S / Prm$$

The characteristic compression breaking load (Prk) is calculated using the following formula:

$$Prk = Prm(1 - \ddot{y}.\ddot{y})$$

Where k is the coefficient of variation and is, for a sample of three panels (n=3), K= 2.92

3.4.2. Results

Table V shows the results of the panel tests. The samples tested meet the acceptance criteria for the Vertical Loads test,

Geometric measurement table

Sample	geometric data			Weight
	Tall cm	Width cm	Thickness cm	kg
Sample 1	244.0	122.0	10.7	80.6
Sample 2	244.8	122.2	11.0	75.8
sample 3	243.5	121.9	11.0	77.6

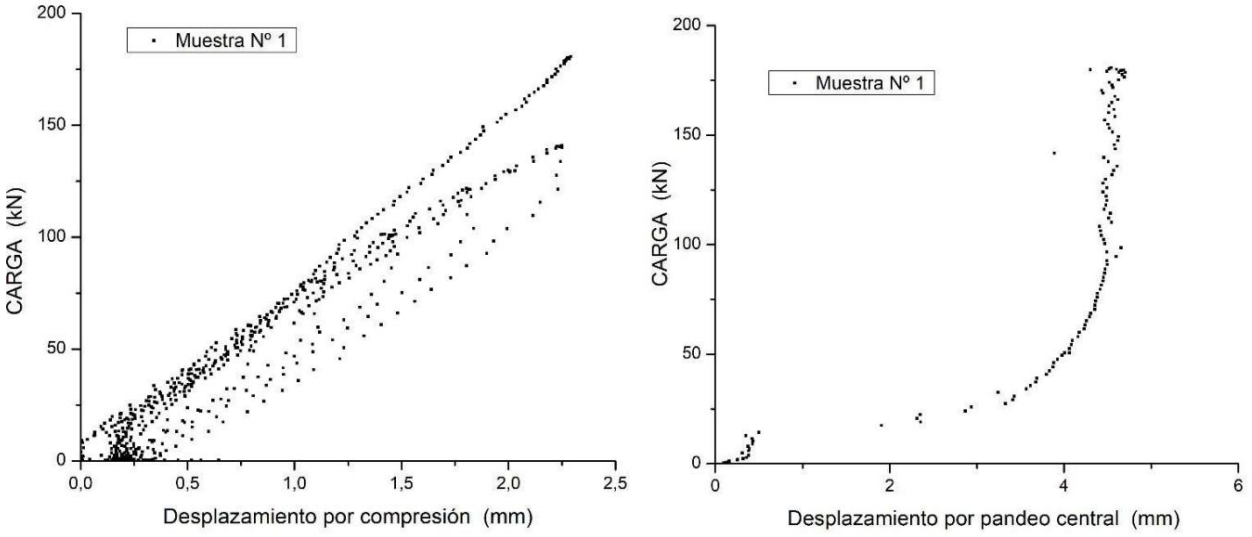
Table No. V. Composition of MGO magnesium sulfate oxide plates + EPS 90 mm + MGO magnesium sulfate oxide plates

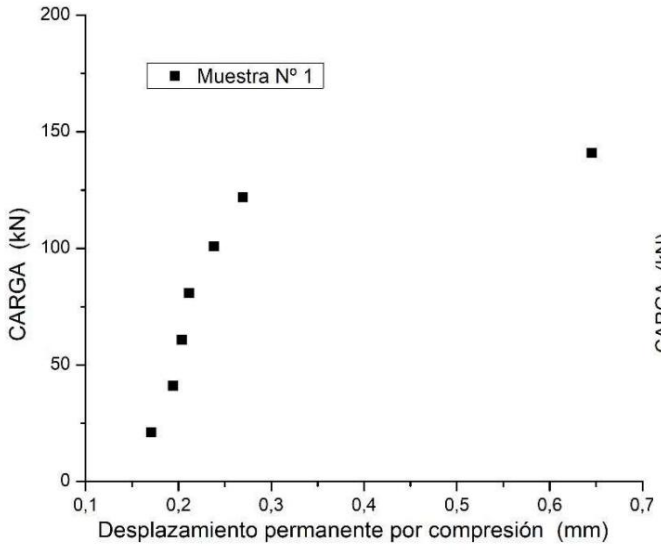
Sample	Maximum Values Reached			Permanent Values		Observations
	Burden KN	side arrow(1) hmm	Axial displacement (2). hmm	Arrow side hmm	axial displacement hmm	
Sample 1	180.20	4.68	2.29	2.79	0.66	Double fracture in left upright
Sample 2	171.47	4.22	3.18	2.83	0.62	Fracture in both uprights
sample 3	187.90	0.52	3.91	1.90	0.53	Fracture in both uprights

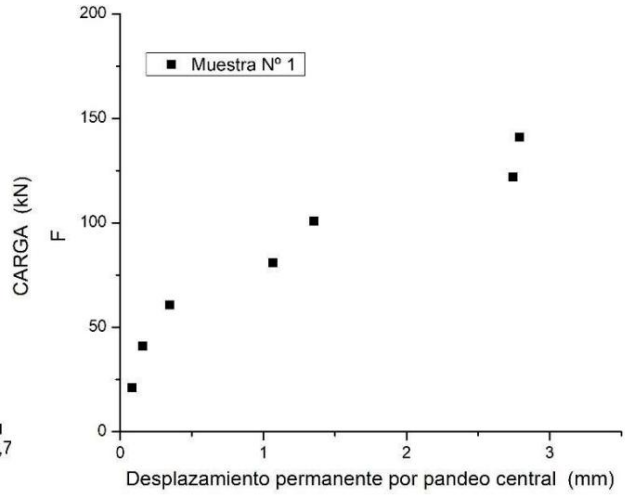
(1) Center buckling deflection is the average of the two LVDTs
(2) Axial displacement is the average of the four potentiometers

Compression test records

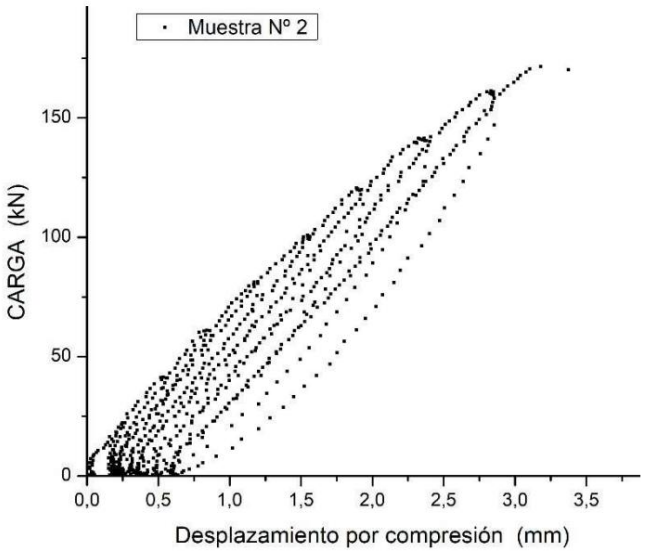
Sample 1

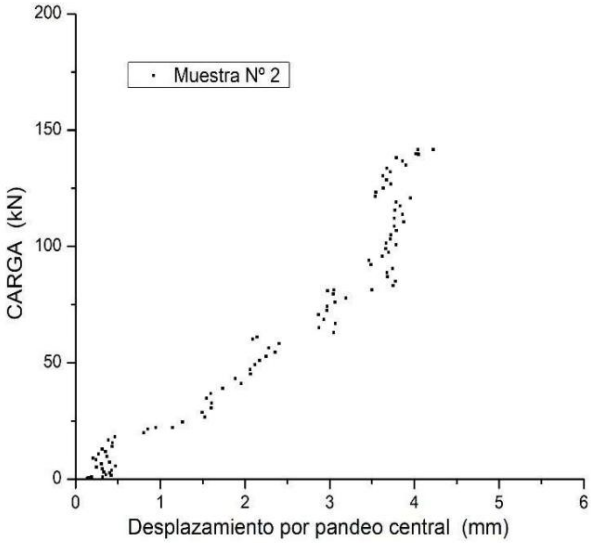


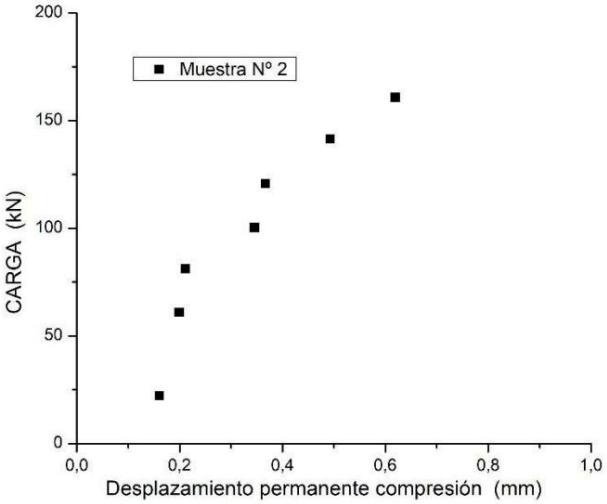


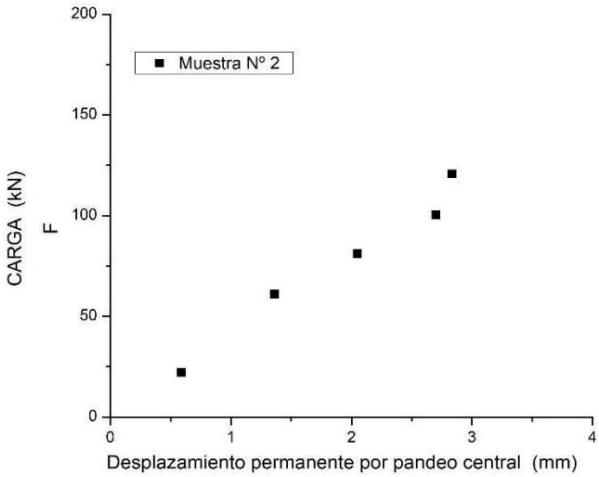


Sample 2

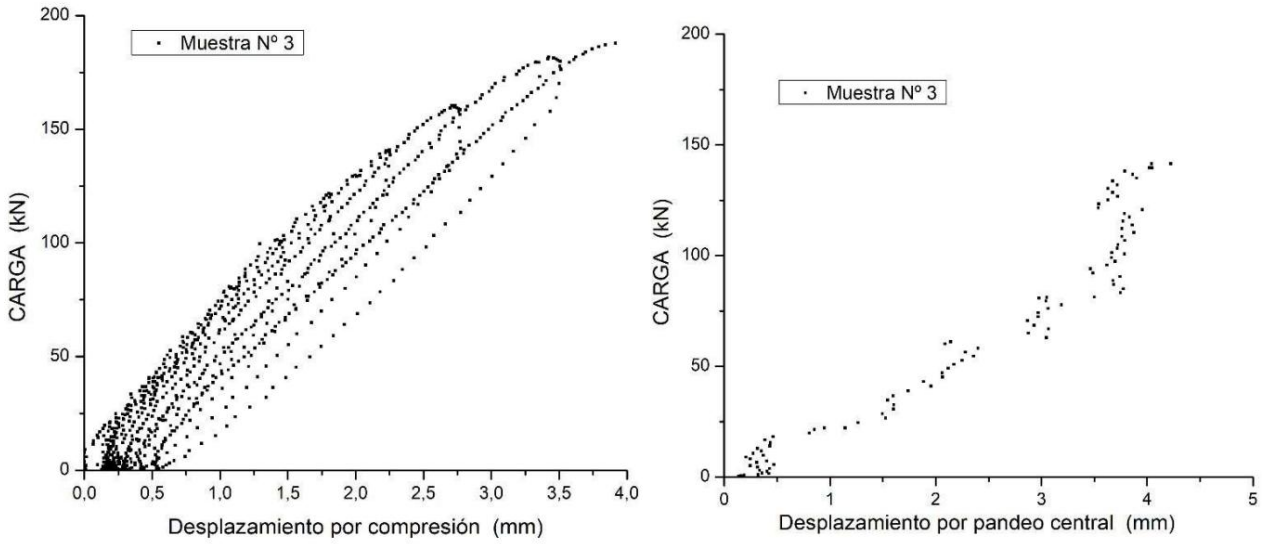


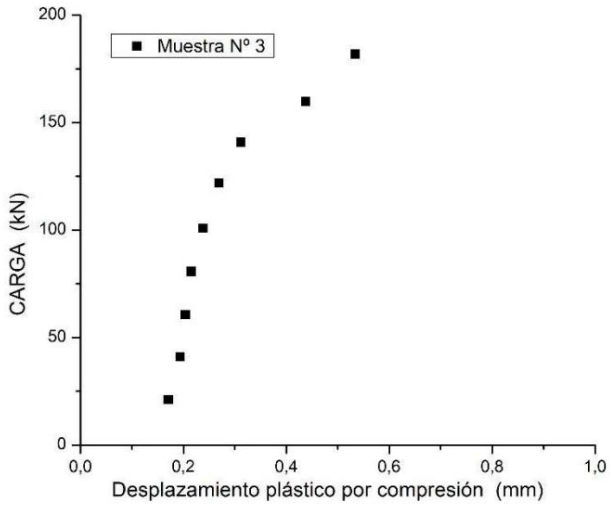


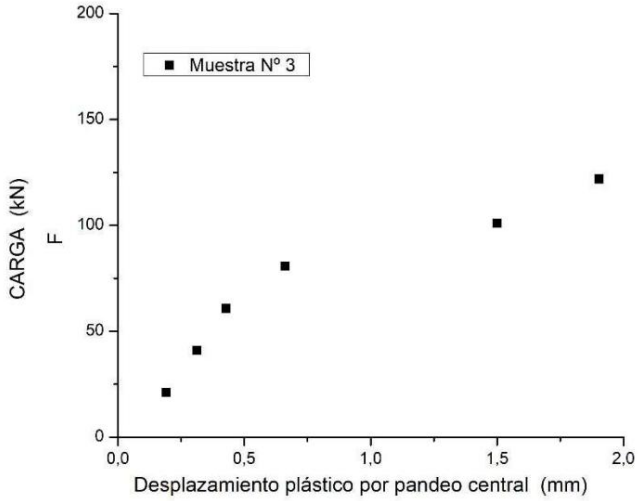




sample 3







Characteristic compression load in Panels composed of MGO oxide magnesium sulphate plates + EPS 90 mm + MGO oxide magnesium sulphate plates

P kr = 155.9KN

Ing. Pablo N. Manzione

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