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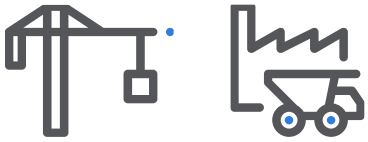
Report N°1619490



# COMPRESSION, HORIZONTAL LOAD, BENDING AND IMPACT TESTS ON SYMMETRICAL PANELS

For Eco Buildings Group

Santiago, April 14 of 2024

Empresa B Certificada

# Report N°1619490

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## Content

# 1 General Rules

- This report provides the final results of the project "Compression, Horizontal Load, Bending and Impact Tests on Symmetrical Panels", developed in March and April 2024
- This report was prepared by DICTUC at the request of the **Client** to evaluate its system, under its sole responsibility.
- The extent of this study is explicitly defined in Chapter 5 of this report. The conclusions of this report are limited to the information available for its execution.
- For the development of this study, DICTUC used the individualized information in Chapter 6, which also identifies the sources that provided the background information.
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## 2 Executive Summary

A series of tests were carried out on symmetrical panels: three compressions (vertical load), three shears (horizontal load), three bending and three impact tests. The prefabricated panels are composed of precast gypsum and glass fibers with the presence of transversal cavities that are filled with concrete at the work site.

Behavior curves and characteristic values were obtained for each of the tests performed. For the compression test, the representative load of the system was 285,62 [KN/m], for the shear test, the representative load was 68,64 [kN/m] and for the bending test, the representative load was 28,74 [kN/m], which is associated with a bending moment of 10,09 [kN·m/m]. The representative load corresponds to the lowest maximum load value obtained for each type of test. Regarding the impact test, no apparent damage was recorded under an impact energy of 120 [J] nor specimen failure for an energy of 240 [J], in addition, the residual deformation did not exceed in any case 30% of the deformation under impact, therefore, it meets the requirements established according to NCh806:2022.

## 3 Introduction

This report discloses the results obtained in the compression, shear, flexural and impact tests on symmetrical panels, carried out between March 14 and April 1, 2024.

The tests were performed at the request of Mr. Sanjay Bowry on behalf of the company Eco Buildings Group, under the acceptance of the work proposal LIE-23-121-00, associated to Ticket 42287.

The tests were carried out by technicians Daniel Hernández and Bruno Quito. This document was prepared by Engineer Cristián de la Torre.

## 4 Objectives

The purpose of the test program is to determine the mechanical properties and behavior of a prefabricated panel system under stresses and procedures based on the 800 series of Chilean normative, specifically from NCh801 to NCh805.

# 5 Extent

The present work described in this report corresponds exclusively to the results of the tests carried out and does not contemplate interpretations of effects or solutions to possible problems that may be implied by the results obtained.

# 6 Background

The test specimens were manufactured and delivered by the client to DICTUC's Structural Engineering Laboratory.

According to the information provided by the client, the tested panels are symmetrical panels composed of precast gypsum and glass fibers, with transversal cavities that are subsequently filled with concrete f'c≥32MPa and a central concrete reinforcement bar Ø12mm $f_y$=420MPa, which implies a unit weight of 240 [kg/m$^2$]. The nominal thickness of the panels is 120 [mm].

Figure 6.1 shows a schematic of the transverse configuration of the panels, as provided by the client.

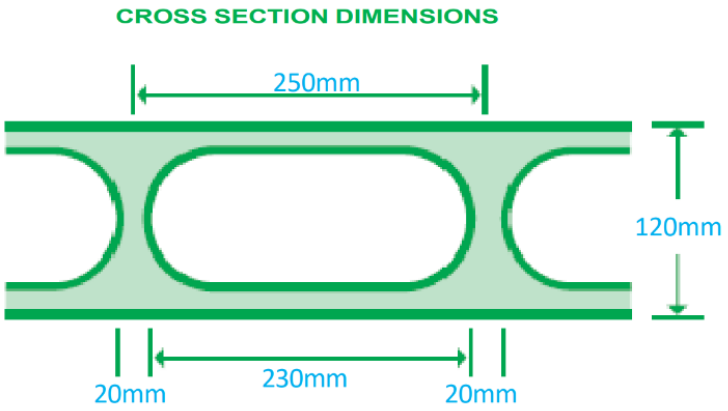



**Figure 6.1. Diagram of the cross section of the panels (provided by the client).**

Figure 6.2 shows the nomenclature used for naming the specimens.

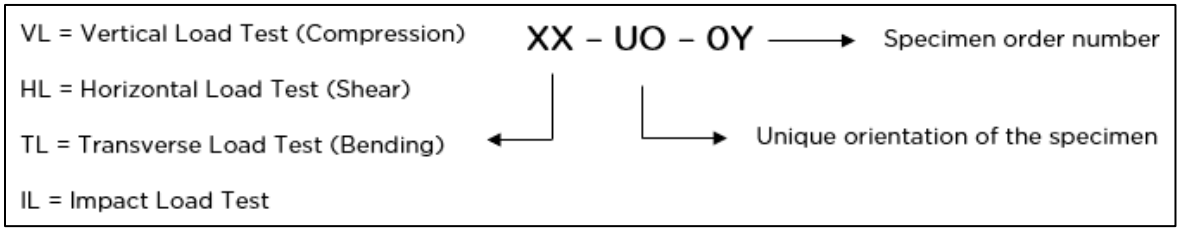



Figure 6.2. Nomenclature used.

Figure 6.3 shows a schematic of the panel's configuration, in this schematic the general dimensions are indicated generically by letters.

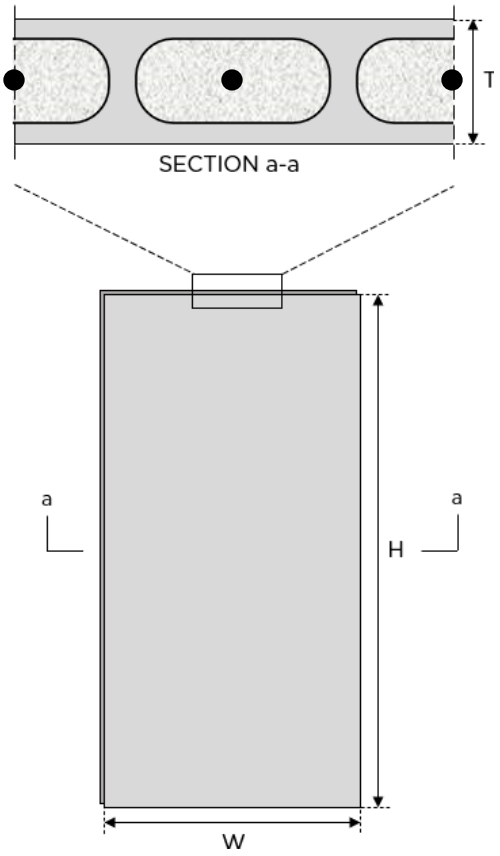



Figure 6.3. Generic schematic of panel configuration.

DICTUC staff carried out the geometric survey of the specimens in order to corroborate their dimensions. Table 6.1 to 6.4 shows the results of the dimensional control of the panels. The measurements are referenced to the nomenclature in Figure 6.3. These values are the ones used in the various calculations presented in this document.

Table 6.1. Panel tested to Compression (vertical load).

| Panel | Test | Height (H) [cm] | Width (W) [cm] | Thickness (T) [mm] | Weight [kgf] |
|---|---|---|---|---|---|
| VL-UO-01 | Vertical Load (Compression) | 244,0 | 136.0 | 128 | 725 |
| VL-UO-02 | Vertical Load (Compression) | 244,5 | 137,4 | 138 | 736 |
| VL-UO-03 | Vertical Load (Compression) | 244,0 | 137,5 | 125 | 719 |

Table 6.2. Panel tested to Shear (horizontal load).

| Panel | Test | Height (H) [cm] | Width (W) [cm] | Thickness (T) [mm] | Weight [kgf] |
|---|---|---|---|---|---|
| HL-UO-01 | Horizontal Load (Shear) | 245,0 | 214,5 | 130 | - |
| HL-UO-02 | Horizontal Load (Shear) | 245.1 | 214,0 | 130 | - |
| HL-UO-03 | Horizontal Load (Shear) | 243,0 | 214,8 | 129 | - |

Table 6.3. Panel tested to Bending (transverse load).

| Panel | Test | Height (H) [cm] | Width (W) [cm] | Thickness (T) [mm] | Weight [kgf] |
|---|---|---|---|---|---|
| TL-UO-01 | Transverse Load (Bending) | 244,3 | 137,0 | 125 | 726 |
| TL-UO-02 | Transverse Load (Bending) | 243,8 | 137,0 | 120 | 712 |
| TL-UO-03 | Transverse Load (Bending) | 245,0 | 137,0 | 125 | 723 |

Table 6.4. Panel tested to Impact.

| Panel | Test | Height (H) [cm] | Width (W) [cm] | Thickness (T) [mm] | Weight [kgf] |
|---|---|---|---|---|---|
| IL-UO-01 | Impact Load | 244,0 | 138,0 | 127 | 731 |
| IL-UO-02 | Impact Load | 244,2 | 135,5 | 140 | 729 |
| IL-UO-03 | Impact Load | 244,0 | 135,4 | 120 | 727 |

# 7 Methodology y Results

## 7.1 Compression Test (Vertical Load)

### 7.1.1 Compression Test Methodology

This test was performed based on the provisions of NCh801:2016. The panels were arranged vertically and the load was applied through two hydraulic cylinders of 30 [ton] capacity and a metal spreader beam over the panel. The load was applied with an eccentricity respect to the center of the panel equal to one sixth of the panel thickness and in a transverse direction to one of the panel faces.

The deformations were recorded by six displacement sensors:

- Four sensors to measure total axial deformation, located at the lower end of the panel, labeled δ1, δ2, δ3 and δ4, two per side (see Photograph 7.1.1.2).
- Two sensors to measure out-of-plane buckling deformations, located horizontally at the center of the panel at each end of the width, labeled δ5 and δ6 (see Photograph 7.1.1.3).

The compression test was performed by applying loading and unloading cycles, in each of the cycles the load was applied quasi-statically and monotonically with load increments of less than one fifth of the maximum load estimated for the panel. Since the strength of the element is unknown, an incremental cycling value was estimated for the first specimen and adjusted for the following specimens. An attempt is made in all cases to perform at least five loading cycles before the panel failure occurs, so that the sixth cycle corresponds to the final cycle and in which the load is increased until the panel failure occurs, without being necessary to record an unloading for that last cycle.

Figure 7.1.1.1 shows the assembly and instrumentation scheme of the compression test. Table 7.1.1.1 shows the details of the equipment used.

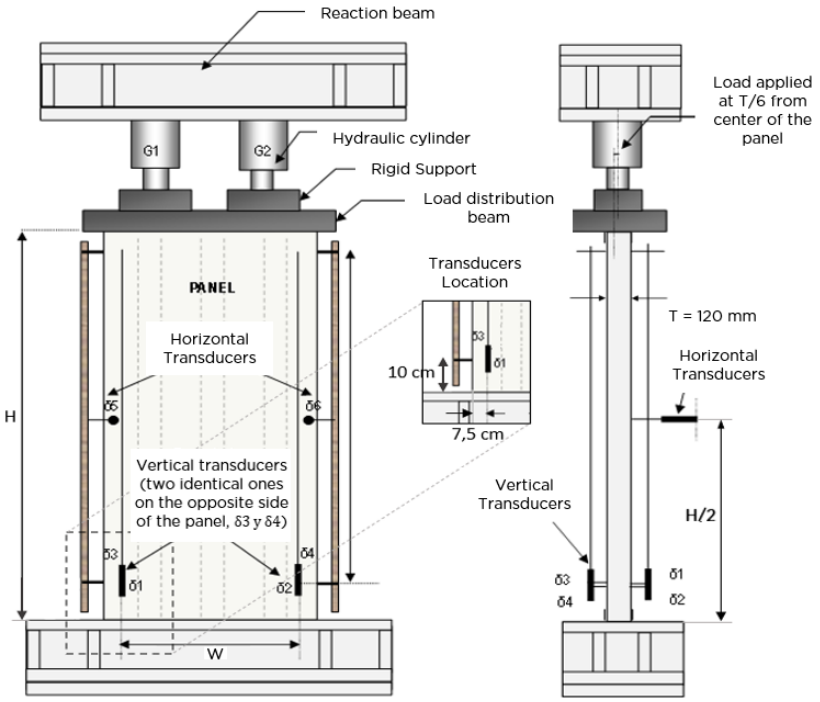



Figure 7.1.1.1. Assembly and instrumentation scheme of the compression test.

Table 7.1.1.1. Elements used in the compression test for traceability.

| Sensor's nomenclature and/or instruments | Description | Brand/ Model | Series Number | Nominal Capacity |
|---|---|---|---|---|
| C | Load Cell | HBM | C2 - FNB28140 | 5 ton |
| δ1 | Vertical Def. North-East | Novotechnik | TR50 -023262/A03 | 50 mm |
| δ2 | Vertical Def. South-East | Novotechnik | TR50 -107759/A05 | 50 mm |
| δ3 | Vertical Def. North-West | Novotechnik | TR50 -107759/A03 | 50 mm |
| δ4 | Vertical Def. South-West | Novotechnik | TR50 -107759/A04 | 50 mm |
| δ5 | Buckling Def. North | Baumer | OM30_11231079 | 300 mm |
| δ6 | Buckling Def. South | Baumer | OM30_1 | 300 mm |
| P1 | Load Application | Enerpac | C3611K | 30 ton |
| P2 | Load Application | Enerpac | C4713K | 30 ton |
| - | Data Acquisition System[1] | HBM | QuantumX MX840A - 9E5004372 | - |

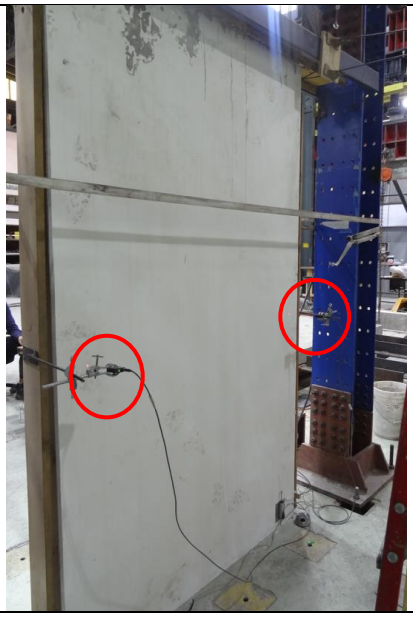
(1) The sampling frequency is 5 Hz.

Photograph 7.1.1.1 shows an overview of the test setup and instrumentation, the hydraulic cylinders, the spreader beam and the reaction system used.

Photograph 7.1.1.1. General overview of the panel subjected to the compression test.

Photographs 7.1.1.2 y 7.1.1.3 shows a detail of the sensors used.

Photograph 7.1.1.2. Two of the four sensors located vertically.



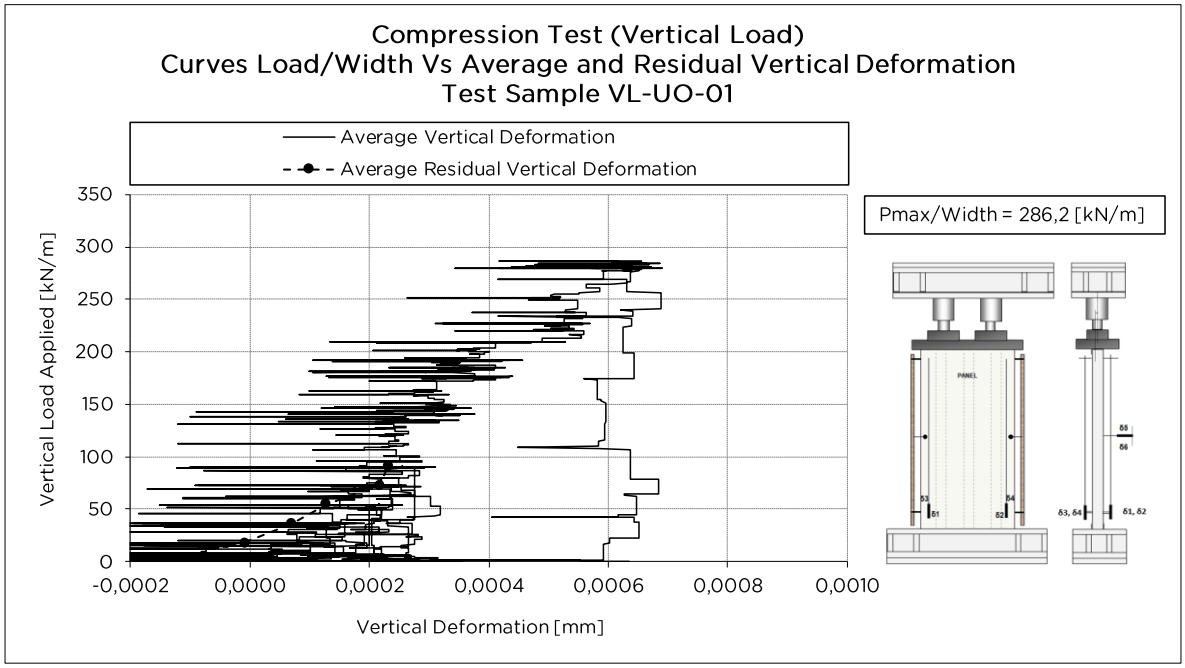
Photograph 7.1.1.3. Detail of the two sensors located horizontally.

### 7.1.2 Compression Test Results

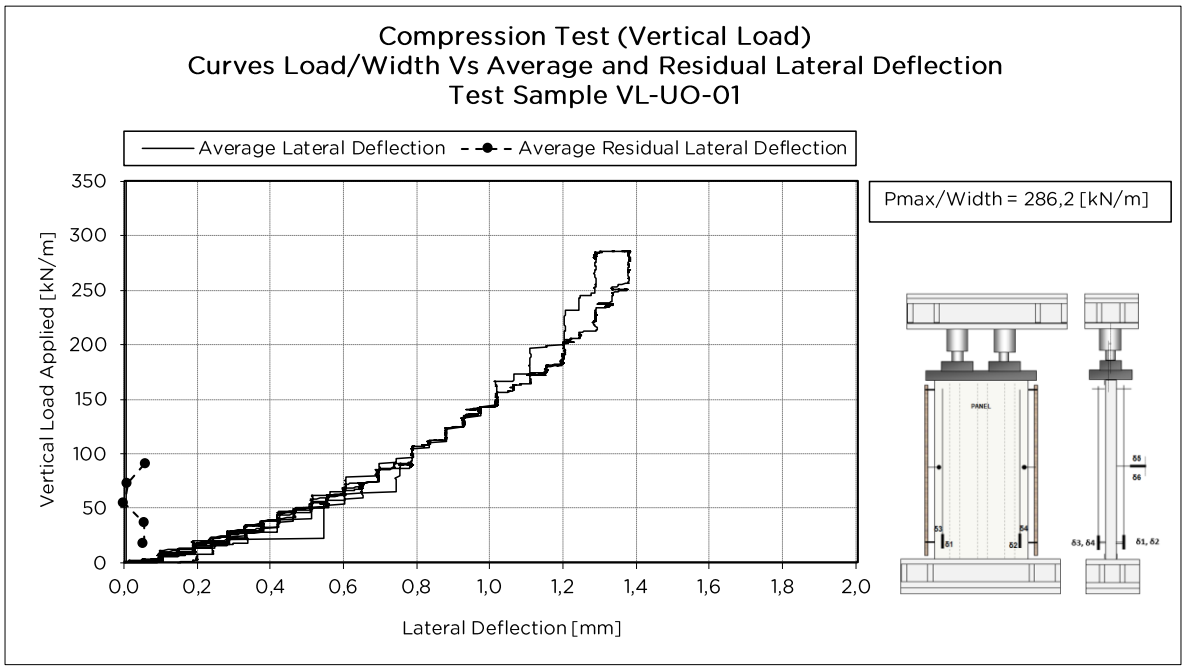
The results are presented through behavior curves and results tables.

The following Graphics present the behavior of the specimen by standardizing the resistance per unit length, according to point 9.3 of NCh801:2016, specifically, the resistance is obtained as the quotient between the registered load and the width of the panel.

- Test Sample Results VL–UO–01

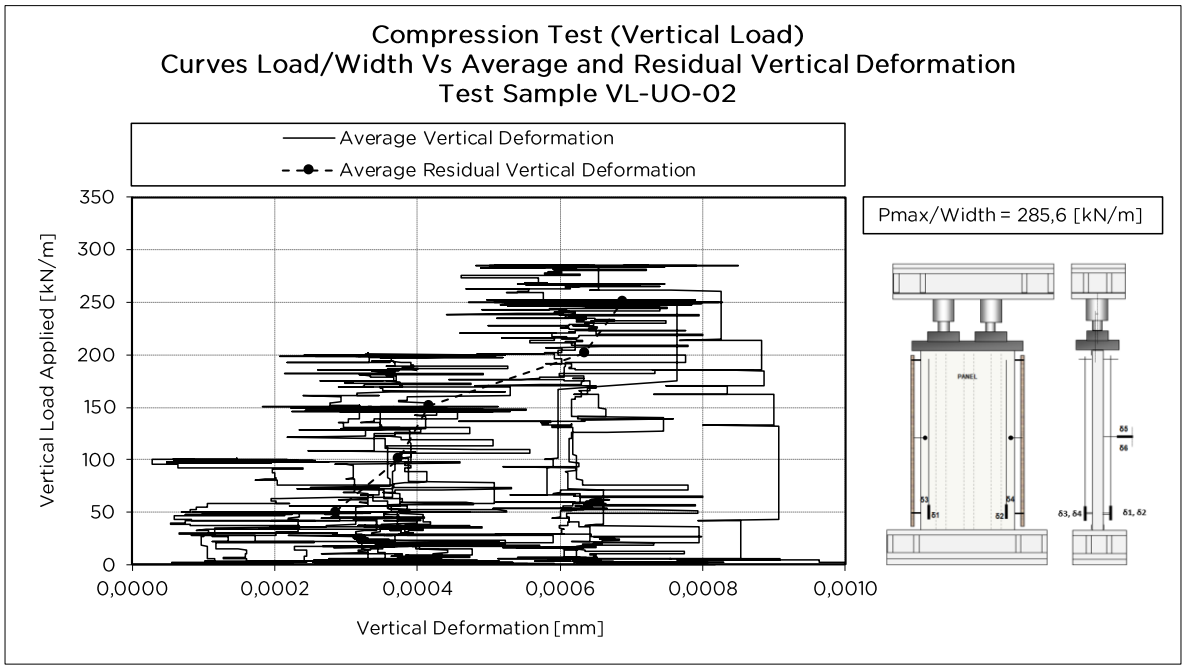



Graphic 7.1.2.1. Curve Load/Width vs Vertical Deformation. Test Sample VL-UO-01.

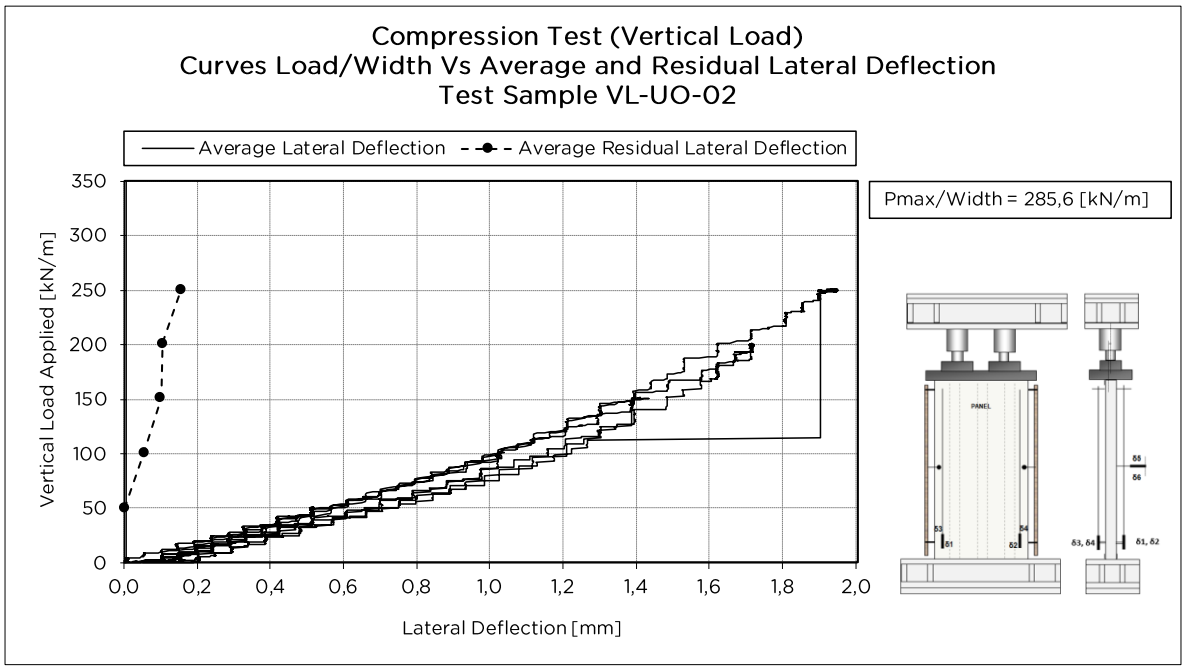



Graphic 7.1.2.2. Curve Load/Width vs Lateral Deflection. Test Sample VL-UO-01.

- Test Sample Results VL–UO–02

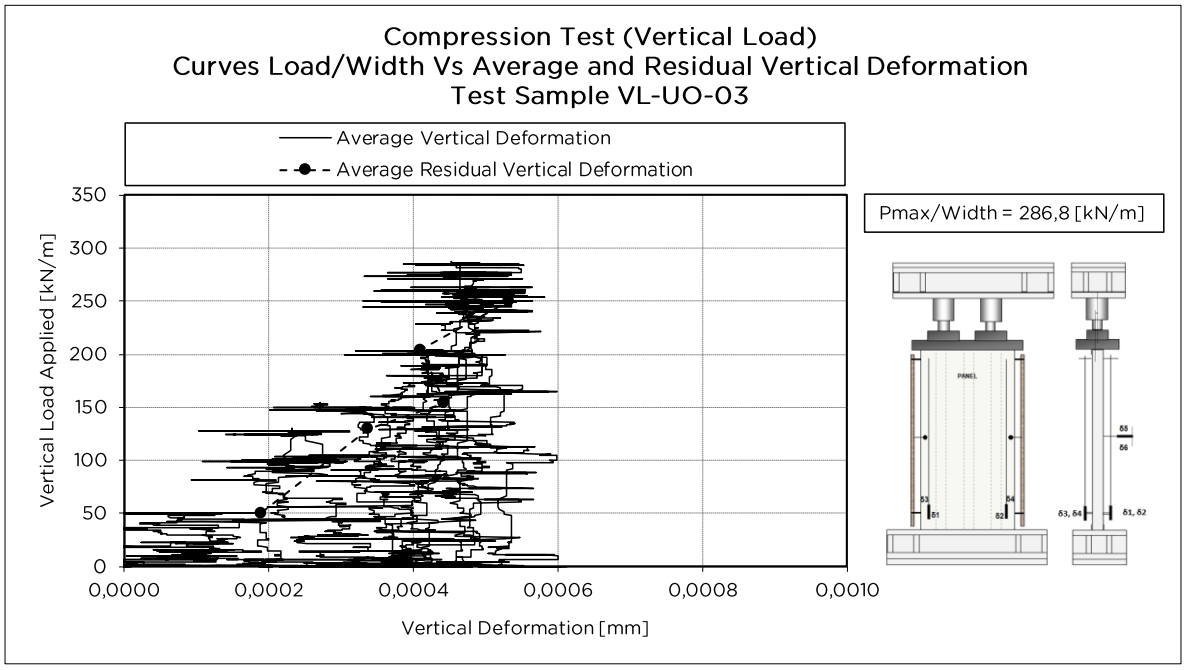



Graphic 7.1.2.3. Curve Load/Width vs Vertical Deformation. Test Sample VL-UO-02.

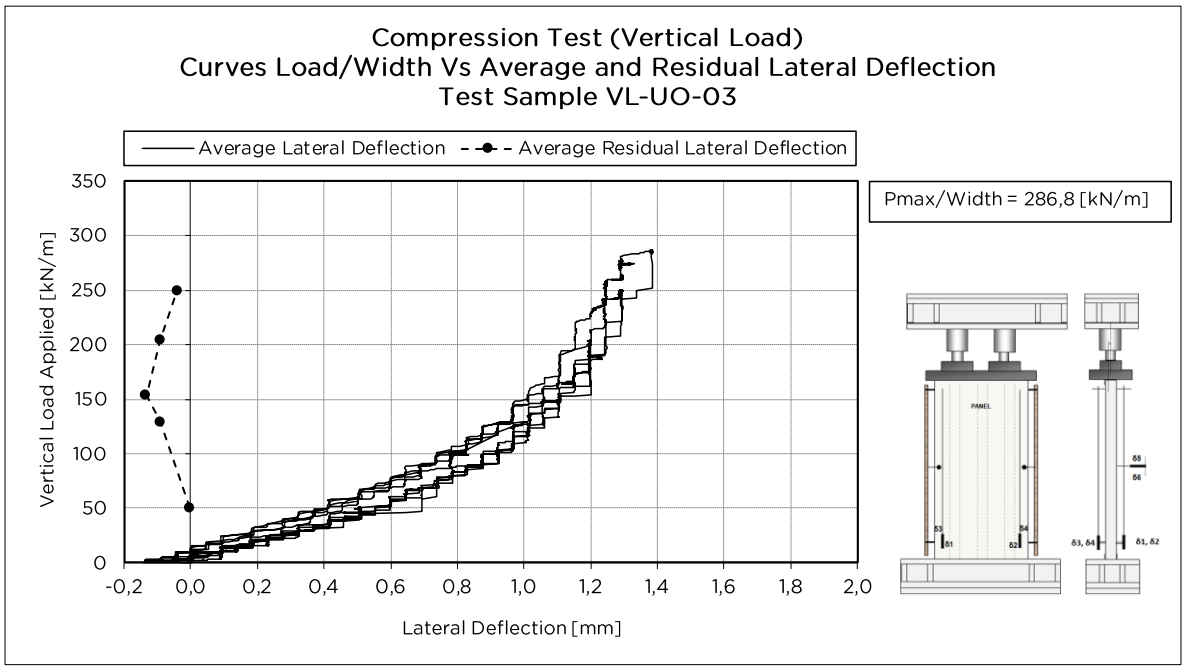



Graphic 7.1.2.4. Curve Load/Width vs Lateral Deflection. Test Sample VL-UO-02.

- Test Sample Results VL–UO–03

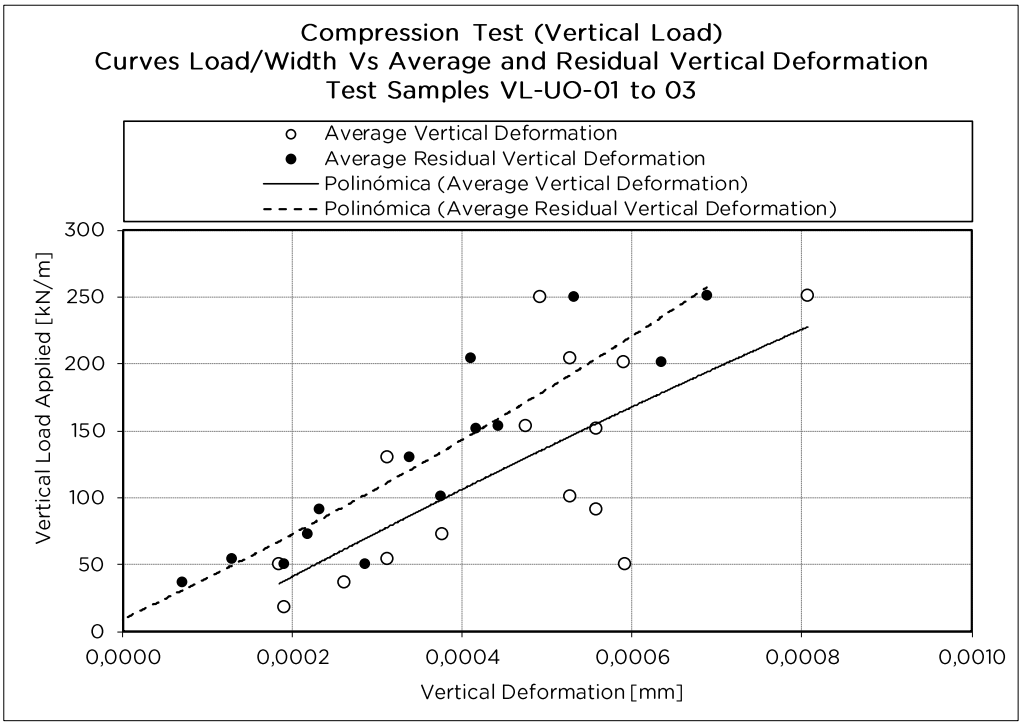



Graphic 7.1.2.5. Curve Load/Width vs Vertical Deformation. Test Sample VL-UO-03.

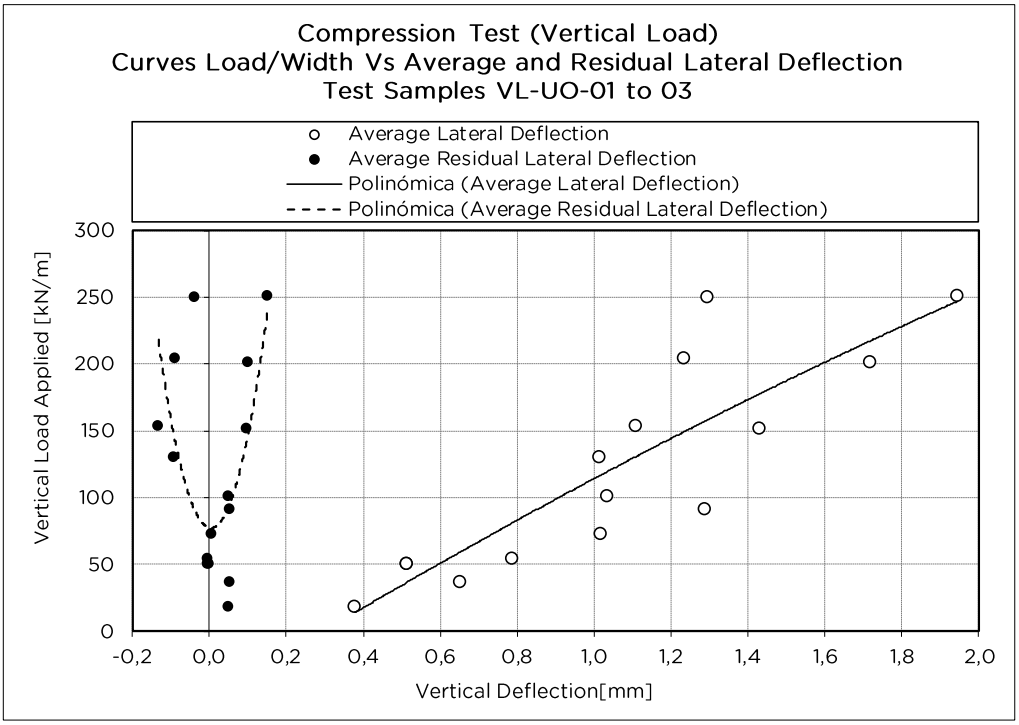



Graphic 7.1.2.6. Curve Load/Width vs Lateral Deflection. Test Sample VL-UO-03.

Graphics 7.1.2.7 and 7.1.2.8 present the curves of the 3 specimens tested in compression. Graphic 7.1.2.7, shows the Load/Width vs Average Vertical Deformation and Average Vertical Residual Deformation behavior curves, with the data of the load/unload cycles of all the specimens tested, according to point 9.3.1 of NCh801:2016. Graphic 7.1.2.8, shows the curves of Load/Width vs Average Lateral Deflection and Residual Average Lateral Deflection, with the data of the load/unload cycles of all the specimens tested, according to point 9.3.2 of NCh801:2016. A fitting curve is presented in each graphic, in continuous line for the vertical deformation and lateral deflection data and in segmented line for the residual cases; the criteria for both trend lines was a second-degree polynomial.




Graphic 7.1.2.7. General behavior curve for Vertical Deformation.




Graphic 7.1.2.8. General behavior curve for Lateral Deflection.

Table 7.1.2.1, presents a summary of the results of the tests performed on each specimen.

Table 7.1.2.1. Summary of the results of the compression tests.

| Test Sample | Pmax[1] [kN/m] | δmax Vertical[2] [mm] | δmax Lateral[3] [mm] |
|---|---|---|---|
| VL-UO-01 | 286,20 | 0,00062 | 1,38 |
| VL-UO-02 | 285,62 | 0,00065 | 1,96 |
| VL-UO-03 | 286,79 | 0,00045 | 1,38 |
| **Average** | 286,20 | 0,00057 | 1,57 |
| **Standard Dev.** | 0,59 | 0,00011 | 0,34 |

(1) Maximum transverse load per width withstood by the panel.
(2) Vertical deformation associated to the maximum load.
(3) Lateral deflection associated to the maximum load.

All samples resisted the maximum load of the compression system, only slight damage was observed at the base due to the compressive force and in the areas where the panels were fastened; however, this has no impact on the bearing capacity. Photograph 7.1.2.1 shows the damage observed.

Photograph 7.1.2.1. Damages associated to the compressive loading.

## 7.2 Shear Test (Horizontal Load)

### 7.2.1 Shear Test Methodology

The present test was performed based on the provisions of NCh802:2017. The panels were arranged vertically and the load was applied with a 50 [ton] capacity shear load frame. The top and bottom ends were embedded across their full width, connecting the panel to the load-bearing frame.

Deformations were recorded through five displacement sensors:

- A sensor used to measure the horizontal displacement of the panel at the level and in the direction of the load application, denoted δ5 (see Photograph 7.2.1.5).
- Two sensors arranged horizontally, labeled δ3 and δ4, to measure possible displacements in the concrete base and in the lower area of the panel (see Photograph 7.2.1.7).
- A vertically arranged sensor, called δ2, to measure the vertical deformation due to panel rotation with respect to the concrete base (see Photograph 7.2.1.6).
- A vertically arranged sensor, labeled δ1, to measure vertical deformation due to rotation of the concrete base (see Photograph 7.2.1.6).

The shear test was carried out by applying loading and unloading cycles, in each of the cycles, the load was applied quasi-statically and monotonically with horizontal load increments of less than one fifth of the maximum load estimated for the panel. Since the strength of the element is unknown, an incremental cycling value was estimated for the first specimen and adjusted for the following specimens. An attempt is made in all cases to perform at least five loading cycles before the panel failure occurs, so that the sixth cycle corresponds to the final cycle and in which the load is increased until the panel failure occurs, without being necessary to record an unloading for that cycle.

Figure 7.2.1.1 shows a schematic of the shear test setup and instrumentation. Table 7.2.1.1 shows the details of the equipment used.

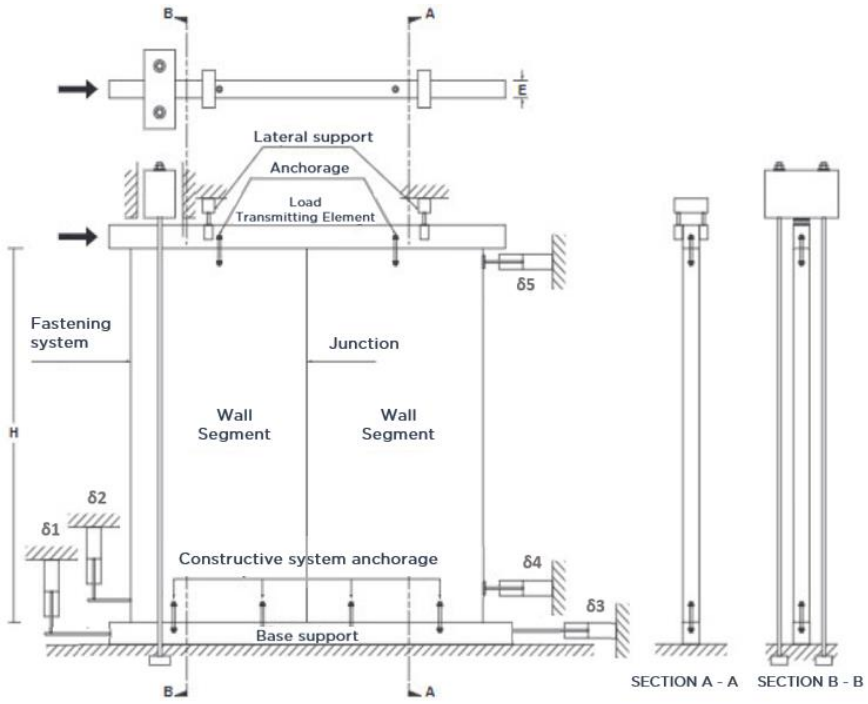



Figure 7.2.1.1. Assembly and instrumentation scheme of the shear test.

Table 7.2.1.1. Elements used in the shear test for traceability.

| Sensor nomenclature and/or instruments | Description | Brand/ Model | Series Number | Nominal Capacity |
|---|---|---|---|---|
| C | Load Cell | Sagino Miya | FLC-500SA | 50 ton |
| δ1 | Vertical Def. Beam | Novotechnik | TR50 - 107759/A03 | 50 mm |
| δ2 | Relative Vertical Def. Panel vs Beam | Novotechnik | TR50 - 107759/A05 | 50 mm |
| δ3 | Horizontal Def. Beam | Novotechnik | TR50 – 023262/A03 | 50 mm |
| δ4 | Inferior Horizontal Def. | Novotechnik | TR50 - 107759/A04 | 50 mm |
| δ5 | Superior Horizontal Def. | Baumer | OM30_11231079 | 300 mm |
| P | Load Application | Jica | - | 30 ton |
| - | Data Acquisition System[1] | HBM | QuantumX MX840A - 9E5004372 | - |

(1) The sampling frequency is 5 Hz.

From Photograph 7.2.1.1 to 7.2.1.3, images of the test setup are shown.

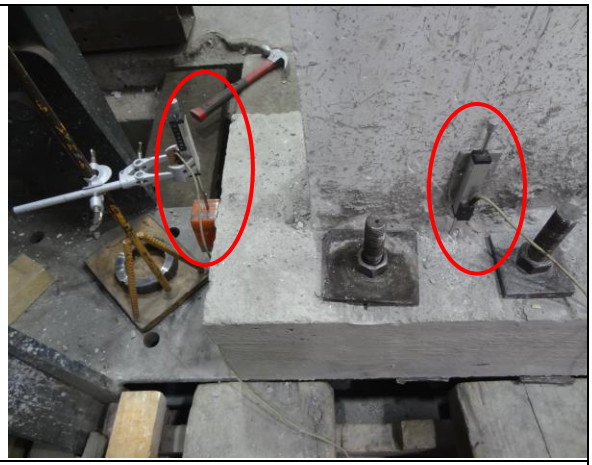
Photograph 7.2.1.1. General view of the horizontal load (shear) test setup.

Photograph 7.2.1.2. Lower attachment to the frame. It's similar to upper attachment.

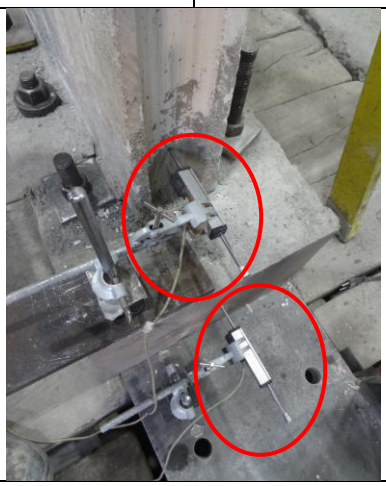
Photograph 7.2.1.3. Equipment used for the horizontal load test.

Finally, from Photograph 7.2.1.4 to 7.2.1.6, images of the sensors used in the shear tests are presented.

Photograph 7.2.1.4. Strain measurement system in the direction of load application δ5.



Photograph 7.2.1.5. Vertical strain transducer δ1 of the base and δ2 of the panel.

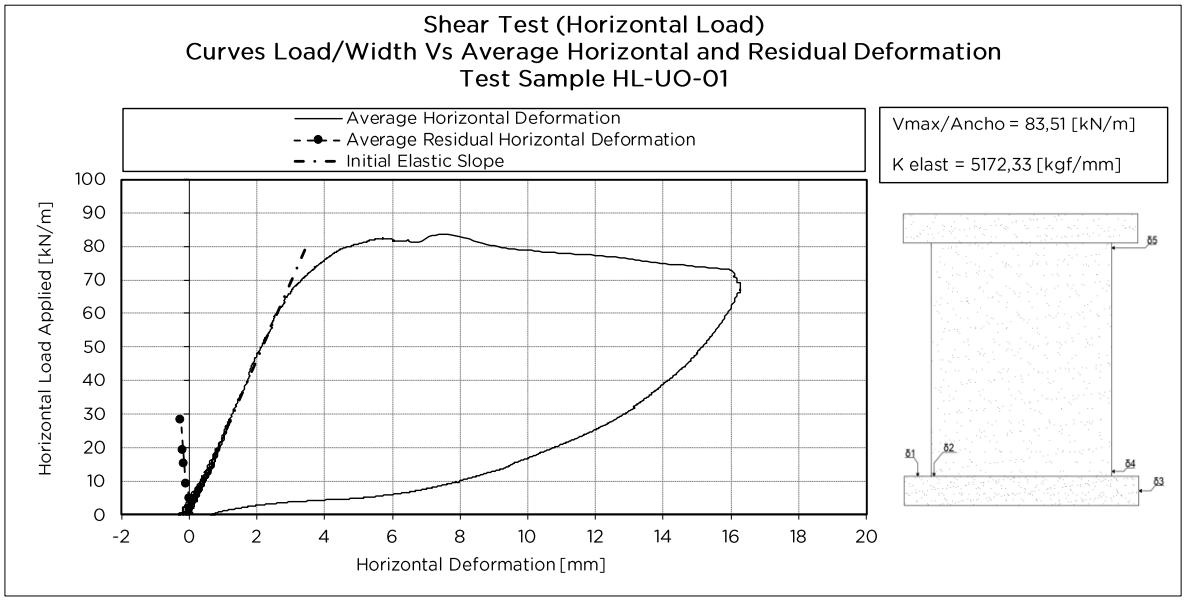


Photograph 7.2.1.6. Horizontal strain transducer δ3 of the base and δ4 of the panel.

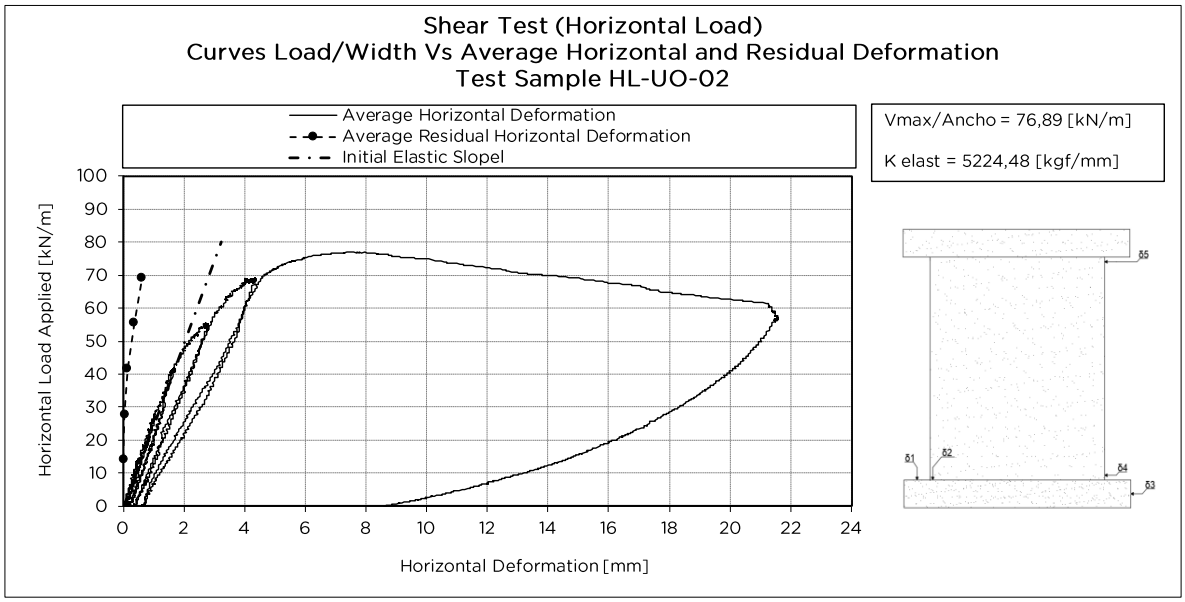
### 7.2.2 Shear Test Results

The results are presented through behavior curves and results tables.

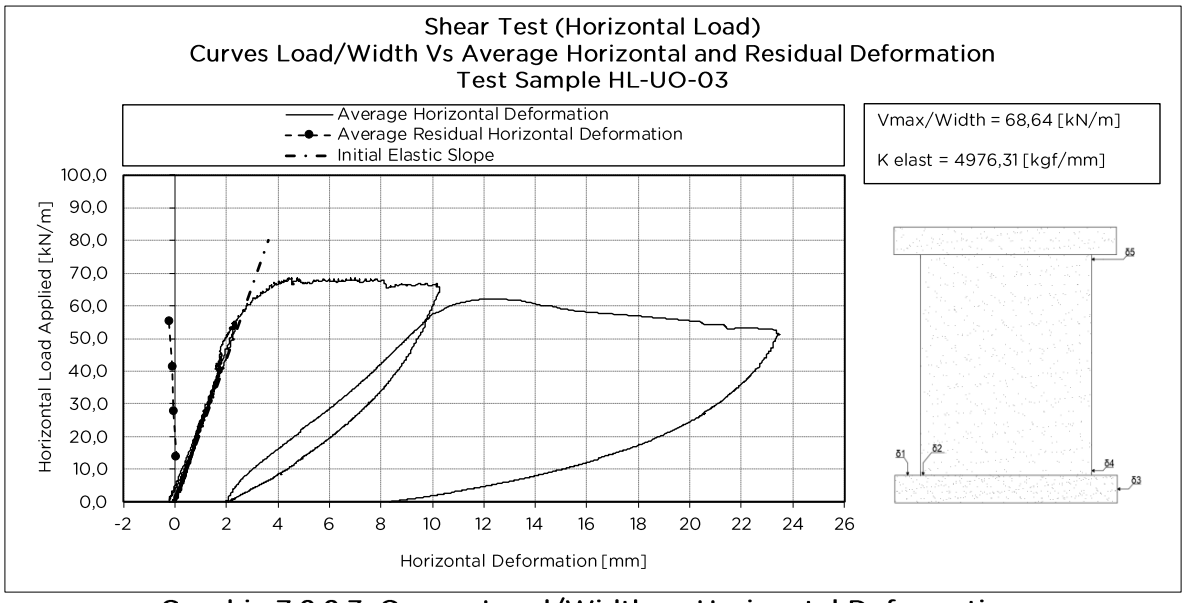
The following graphics present the behavior of the specimen by standardizing the resistance per unit length, in this case the width of the panel, according to point 10.3 of NCh802:2017. In addition, the elastic stiffness was added with values between 10% and 45% of the maximum load.




Graphic 7.2.2.1. Curves Load/Width vs Horizontal Deformation.
Test Sample HL-UO-01.

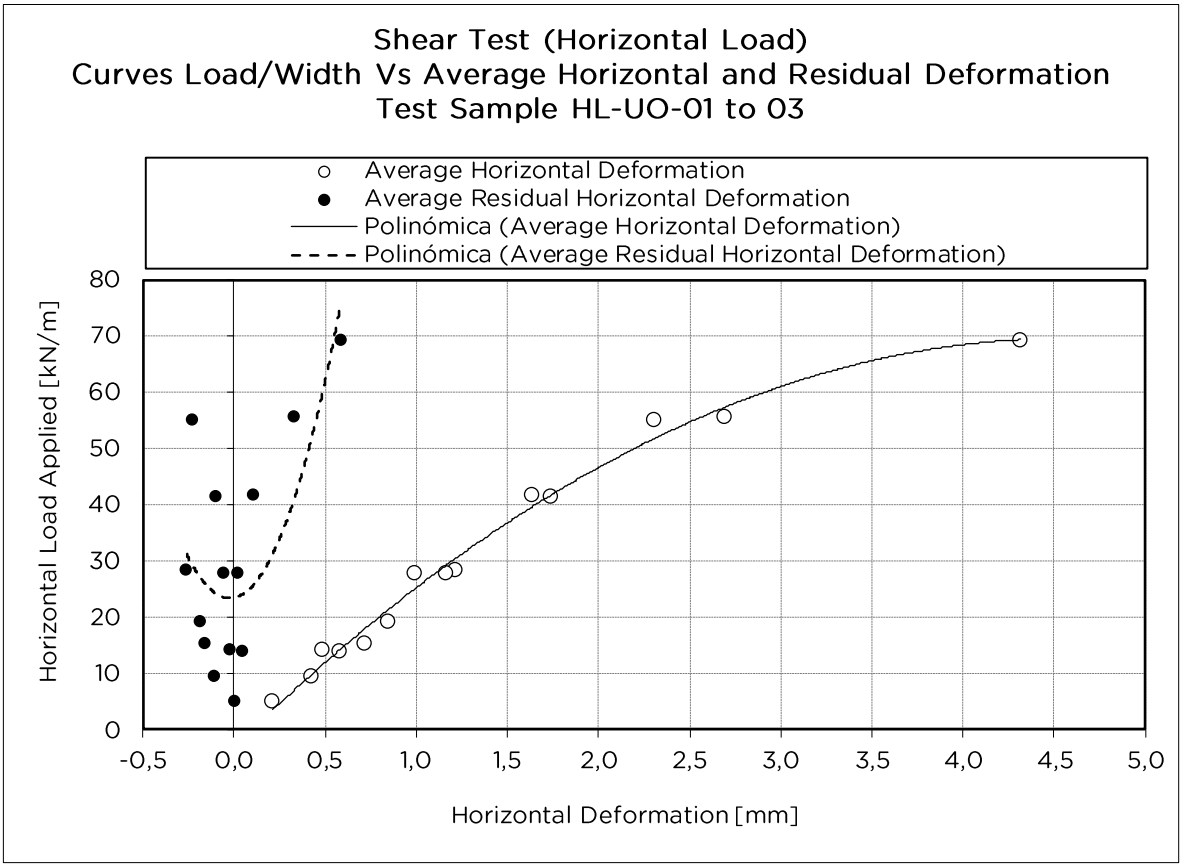



Graphic 7.2.2.2. Curves Load/Width vs Horizontal Deformation.
Test Sample HL-UO-02.




Graphic 7.2.2.3. Curves Load/Width vs Horizontal Deformation.
Test Sample HL-UO-03.

Graphic 7.2.2.4 shows a summary for the 3 specimens tested in shear. Graphic 7.2.2.4, shows the curves Maximum Load/Width vs Average Horizontal Deformation and Average Residual Horizontal Deformation, with the data of the load/unload cycles for all the specimens tested, according to point 10.3.1 of NCh802:2017. A fitting curve for the Average Horizontal Deformation data is presented in continuous line and for the Residual Horizontal Deformation data in segmented line; the criteria for both trend lines was a second-degree polynomial.




Graphic 7.2.2.4. General behavior curve.

Table 7.2.2.1 presents a summary of the test results.

Table 7.2.2.1. Summary of the results of the shear tests.

| Test Sample | Vmax[1] [kN/m] | δmax[2] [mm] | K elast[3] [kgf/mm] |
|---|---|---|---|
| HL-UO-01 | 83,51 | 7,50 | 5172,33 |
| HL-UO-02 | 76,89 | 7,59 | 5224,48 |
| HL-UO-03 | 68,64 | 4,54 | 4976,31 |
| **Average** | 76,35 | 6,54 | 5124,37 |
| **Standard Dev.** | 7,45 | 1,73 | 130,86 |

(1) Maximum horizontal load per width withstood by the panel.
(2) Horizontal deformation associated to the maximum load.
(3) Elastic stiffness corresponding to load values up to 45% of the maximum load.

The typical failure mechanism of the specimens was shear failure, with mostly diagonal and some vertical cracks, as shown in Photographs 7.2.2.1 to 7.2.2.3 of each sample.

Photograph 7.2.2.1. Appearance of vertical cracks and slight diagonal cracks for specimen HL-UO-01.

Photograph 7.2.2.2. Typical shear failure in test sample HL-UO-02. Diagonal cracks are observed.

Photograph 7.2.2.3. Typical shear failure in test sample HL-UO-03. Diagonal cracks are observed.

## 7.3 Bending Test (Transverse Load)

### 7.3.1 Bending Test Methodology

The present test was performed based on the provisions of NCh803:2016. The panel was arranged horizontally at floor level, but taking care to leave a space for free deflection of the span of the element. The panel was supported at both ends over its full width, the panel supports consisted of a fixed ball joint and a sliding ball joint. The load is applied by 30 [ton] capacity hydraulic cylinder that distributes the load to the quarters of the span, over the surface of the panel. The total weight of the loading system is 68 kg (load distributing element consisting of a steel plate supported on the midpoint of a steel beam, which is supported perpendicularly on two tubular sections).

Deformations were recorded by six displacement sensors:

- Two sensors located at the center of the panel span, denoted δ1 and δ2 (see Figure 7.3.1.1).
- Four sensors located on all four edges of the panel, denoted δ3, δ4, δ5 and δ6 (see Figure 7.3.1.1).

The bending test was performed by applying loading and unloading cycles, in each of the cycles, the load was applied quasi-statically and monotonically with vertical load increments of less than one fifth of the maximum load estimated for the panel. Since the strength of the element is unknown, an incremental cycling value was estimated for the first specimen and adjusted for the following specimens. An attempt is made in all cases to perform at least five loading cycles before panel failure occurs, so that the fifth or sixth cycle corresponds to the final cycle and in which the load is increased until panel failure occurs, without it being necessary to record an unloading for that cycle.

Figure 7.3.1.1 shows the schematic of the setup and instrumentation of the bending test. Table 7.3.1.1 shows the details of the equipment used.

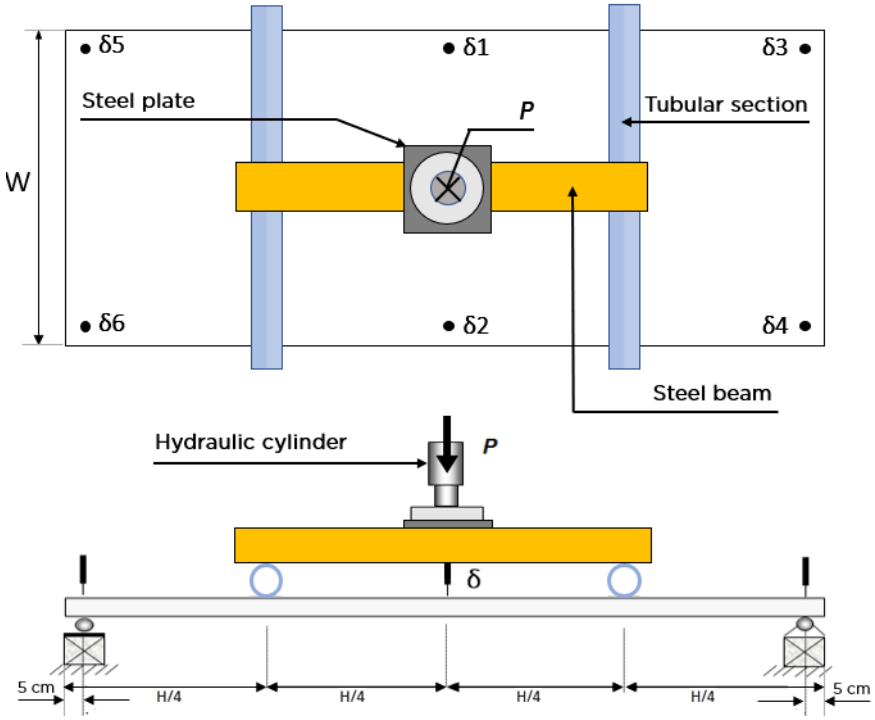


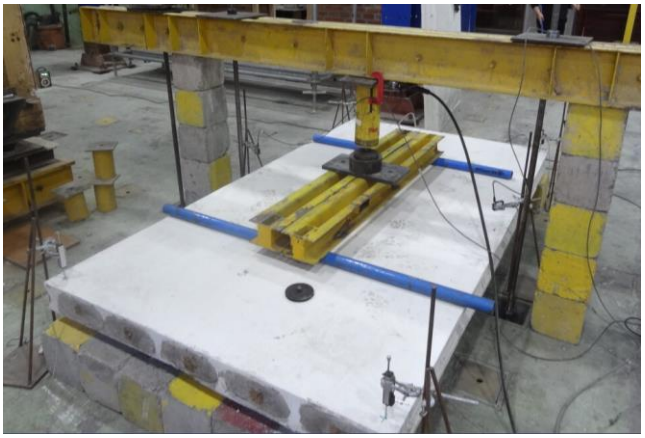

Figure 7.3.1.1. Setup and instrumentation scheme of the bending test.

Table 7.3.1.1. Elements used in the bending test for traceability.

| Sensor nomenclature and/or instruments | Description | Brand/ Model | Series Number | Nominal Capacity |
|---|---|---|---|---|
| C | Load Cell | HBM | C2 - FNB28140 | 5 ton |
| δ1 | Central Vertical Def. West | Baumer | OM30_3 | 300 mm |
| δ2 | Central Vertical Def. East | Baumer | OM30_11231079 | 300 mm |
| δ3 | Vertical Def. North-West | Novotechnik | TR50 - 107155/A09 | 50 mm |
| δ4 | Vertical Def. North-East | Novotechnik | TR50 - 107759/A01 | 50 mm |
| δ5 | Vertical Def. South-West | Novotechnik | TR50 – 023262/A01 | 50 mm |
| δ6 | Vertical Def. South-East | Novotechnik | TR50 – 107759/A04 | 50 mm |
| P | Load Application | Enerpac | C0207C | 30 ton |
| - | Data Acquisition System[1] | HBM | QuantumX MX840A - 9E5004372 | - |

(1) The sampling frequency is 5 Hz.

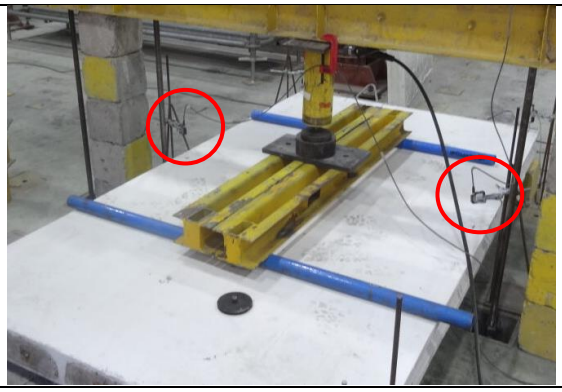
Photograph 7.3.1.1 shows a general view of the setup and instrumentation of the test.



Photograph 7.3.1.1. setup and instrumentation of the bending test.

Photographs 7.3.1.2 y 7.3.1.3 shows the detail of the sensors used.

Photograph 7.3.1.2. Detail of the transducers to measure the deformation in the sector of the supports, δ3 and δ4.

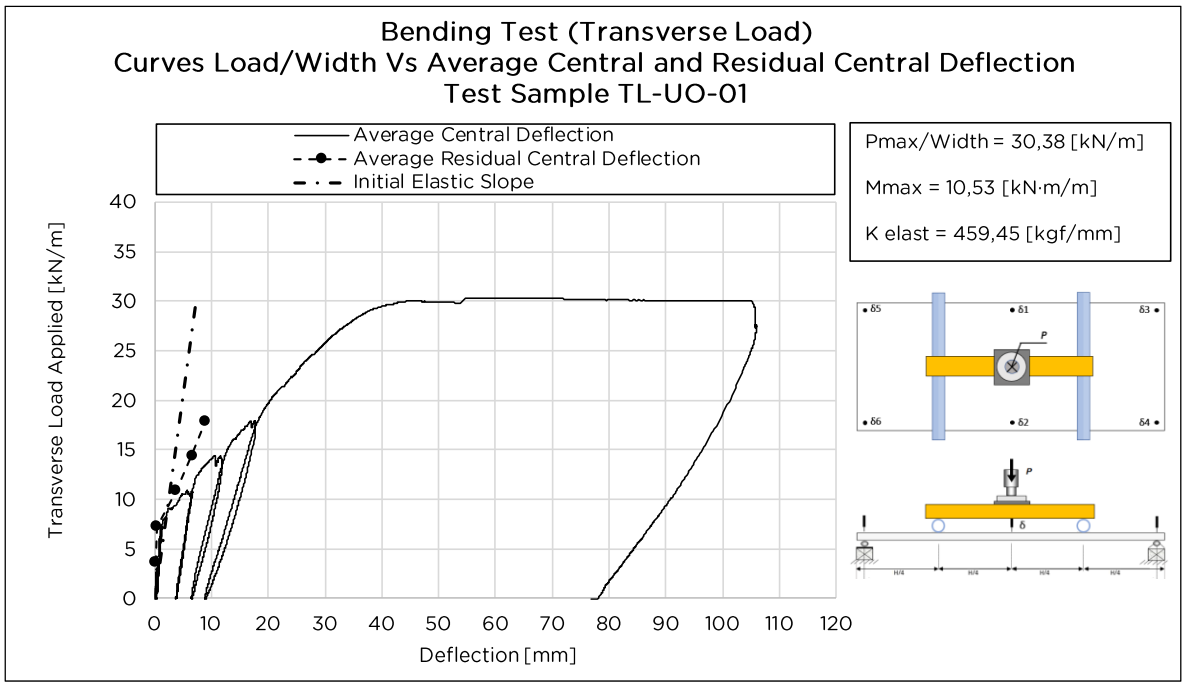


Photograph 7.3.1.3. Detail of the sensors arranged to measure the central deflection, δ1 and δ2.

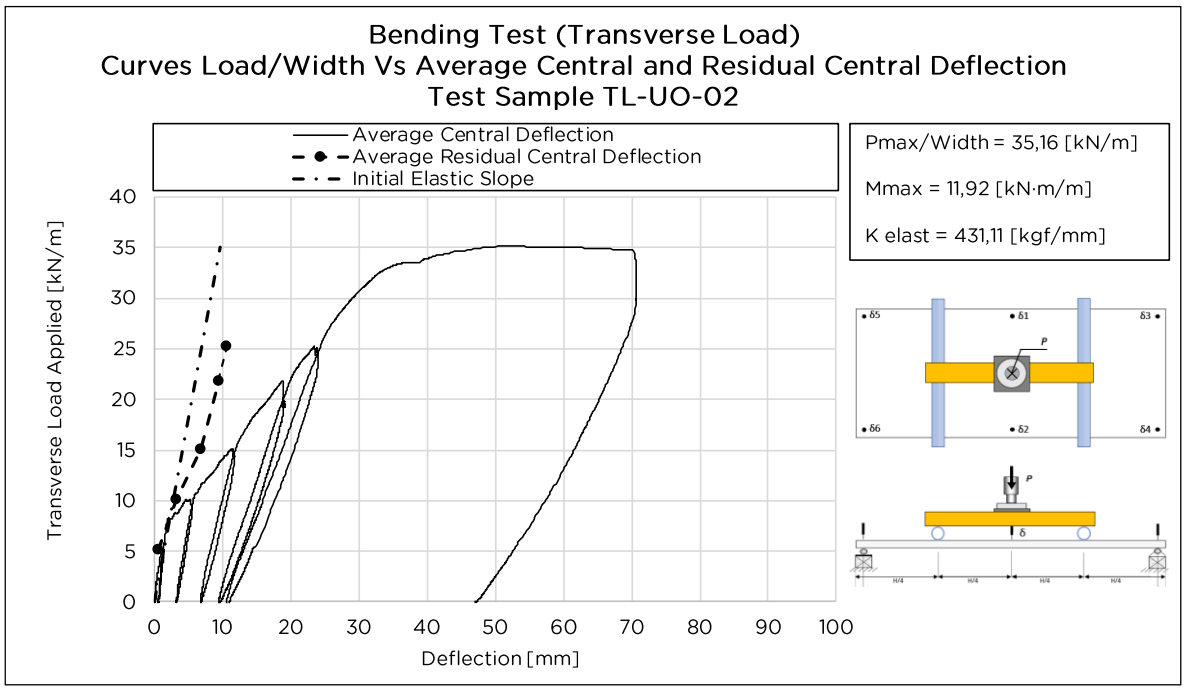
### 7.3.2 Bending Test Results

The results are presented through performance curves and results tables.

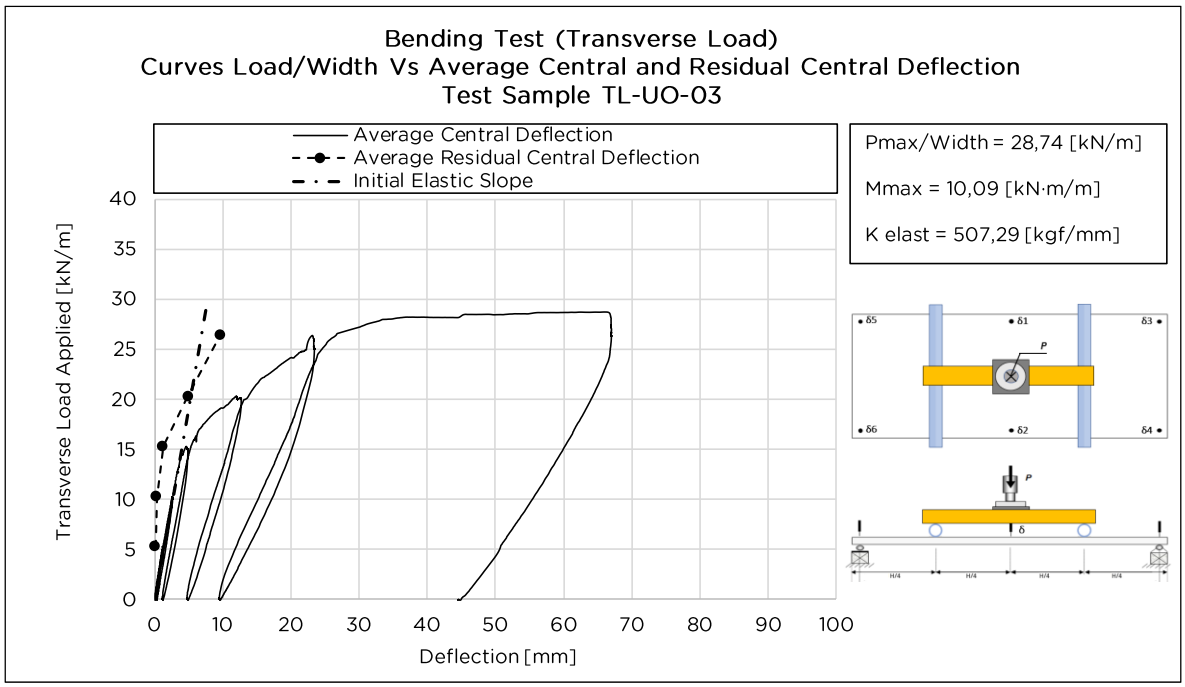
The following graphics present the behavior of the specimen by standardizing the resistance per unit length, in this case the width of the panel, according to point 9.3 of NCh803:2016. In addition, the elastic stiffness was added with values between 10% and 45% of the maximum load.




Graphic 7.3.2.1. Curve Load/Width vs Central Deflection. Test Sample TL-UO-01.

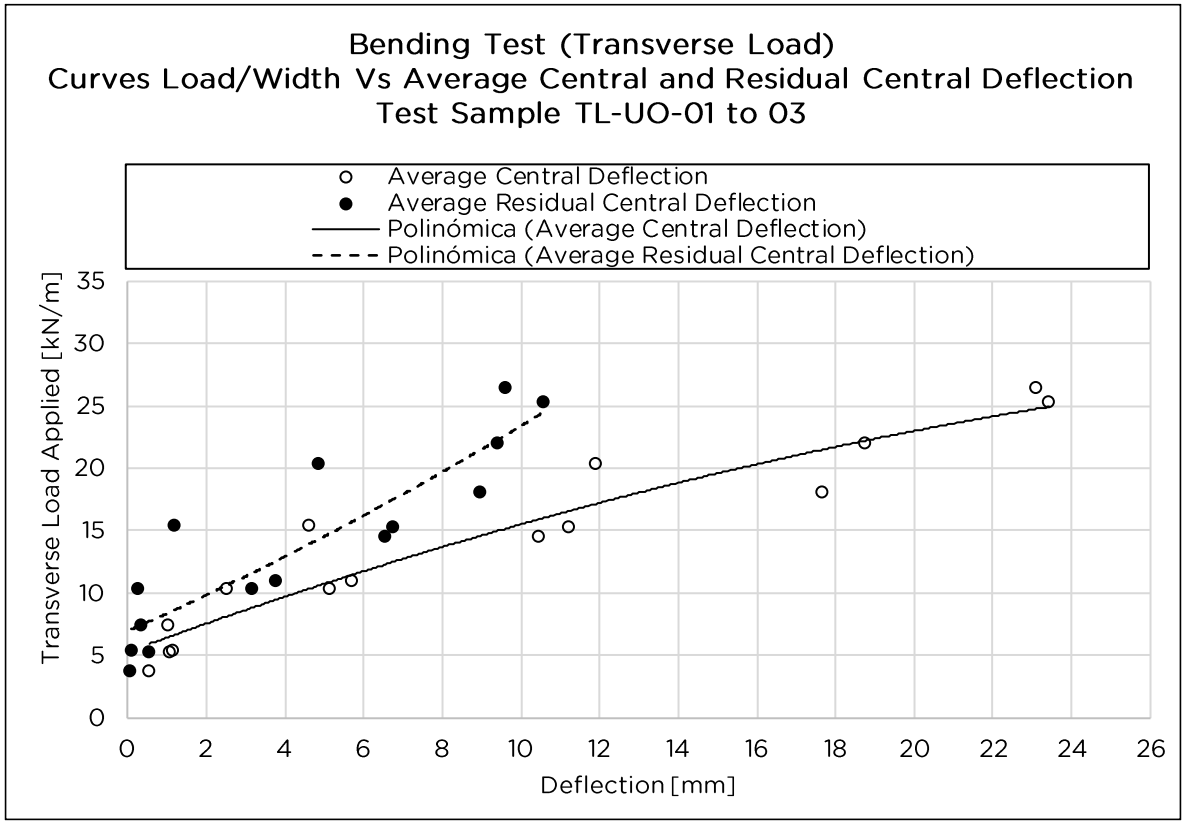



Graphic 7.3.2.2. Curve Load/Width vs Central Deflection. Test Sample TL-UO-02.




**Graphic 7.3.2.3. Curve Load/Width vs Central Deflection. Test Sample TL-UO-03.**

Graphic 7.3.2.4 shows the Maximum Load/Width vs. Average Central Deflection and Residual Central Deflection behavior curves, with the data of the load/unload cycles of all the specimens tested, according to point 9.3 of NCh803:2016. A fitting curve for the Average Central Deflection data is presented in continuous line and a fitting curve for the Residual Central Deflection data is presented in segmented line; the criteria for both trend lines was a second-degree polynomial.




Graphic 7.3.2.4. General behavior curve.

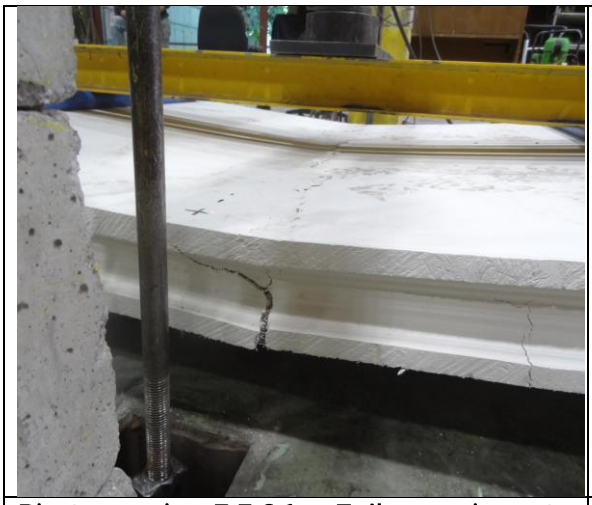
Table 7.3.2.1 presents a summary of the test results. In addition, the bending moment due to the maximum load at the center of the panel and the elastic stiffness are added for each test.

Table 7.3.2.1. Summary of the results of the bending tests.

| Test Sample | Pmax[1] [kN/m] | δmax[2] [mm] | Mmax[3] [kN·m/m] | K elast[4] [kgf/mm] |
|---|---|---|---|---|
| TL-UO-01 | 30,38 | 58,58 | 10,53 | 459,45 |
| TL-UO-02 | 35,16 | 51,23 | 11,92 | 431,11 |
| TL-UO-03 | 28,74 | 65,91 | 10,09 | 507,29 |
| **Average** | 31,43 | 58,57 | 10,85 | 465,95 |
| **Standard Dev.** | 3,33 | 7,34 | 0,96 | 38,50 |

(1) Maximum transverse load per width withstood by the panel (includes external load and the weight of the load application system).
(2) Deformation associated to the maximum transverse load
(3) Bending moment calculated as $(P{\cdot}L\ /8) + (q{\cdot}L^2/8)$, where $P$ is the external load applicated at center of the panel (includes the weight of the load application system), $q$ is the weight of the panel and $L$ es the free span between supports.
(4) Elastic stiffness corresponding to load values up to 45% of the maximum load.

The typical failure mechanism of the specimens was transverse breakage of the gypsum skeleton at the center of the panel or under one of the load lines. Photograph 7.3.2.1 shows the failure of specimen TL-UO-01 and Photograph 7.3.2.2, of specimens TL-UO-02 and 03.



Photograph 7.3.2.1. Failure due to breakage of the panel in the central sector.

Photograph 7.3.2.2. Failure due to panel breakage under load line.

## 7.4 Impact Test

### 7.4.1 Impact Test Methodology

The present test was performed based on the provisions of NCh804:2017. The panels were tested in a horizontal position, simply supported at each corner and the application of the impact load for this case is performed in the center span of the panel. The mass with which the impact is applied corresponds to a leather cylinder, which contains hardened lead pellets of 2.4 mm diameter. The impact bag has a weight of 27.4 kg, which is released from different levels of height set to generate different levels of energy. The mass is attached to a fixed ball and socket joint via a 400 cm long rope. A displacement sensor was placed on the back of the panel to record the deformations generated at the impact point of the panel.

The test starts with a height of 15 cm and is continued by increasing the drop height by 15 cm in the following impacts. At each impact, the deformation produced in the panel on the face opposite to the application of the stress is

measured under the same point of impact. The test continues until a height of 120 cm is reached or the panel breaks after a minimum of 6 impacts.

The position of the panel and the component elements of the test are shown in the diagram in Figure 7.4.1.1. and Table 7.4.1.1 shows the details of the equipment used.

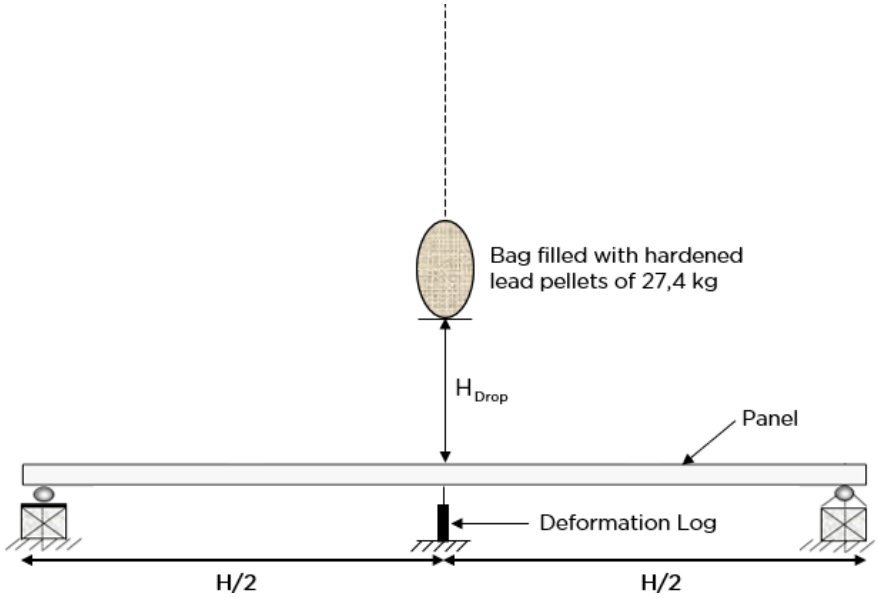



Figure 7.4.1.1. Setup and instrumentation scheme of the impact test.

Table 7.4.1.1. Elements used in the impact test for traceability.

| Sensor nomenclature and/or instruments | Description | Brand/ Model | Series Number | Nominal Capacity |
|---|---|---|---|---|
| δ | Central Horizontal Def. | Baumer | OM30_11231079 | 300 mm |
| - | Data Acquisition System[1] | HBM | QuantumX MX840A - 9E5004372 | - |

(1) The sampling frequency is 300 Hz.

Photograph 7.4.1.1 shows an overview of the test setup and instrumentation.

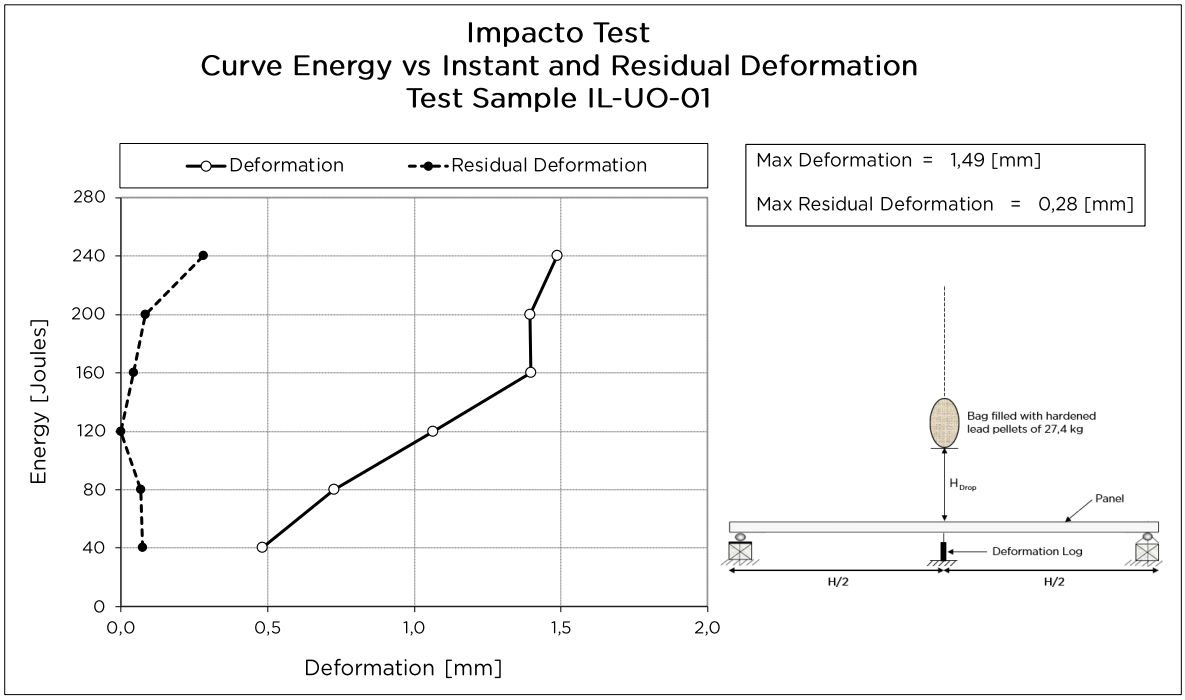
Photograph 7.4.1.1. General view of the setup of the panel subjected to the impact test.

### 7.4.2 Impact Test Results

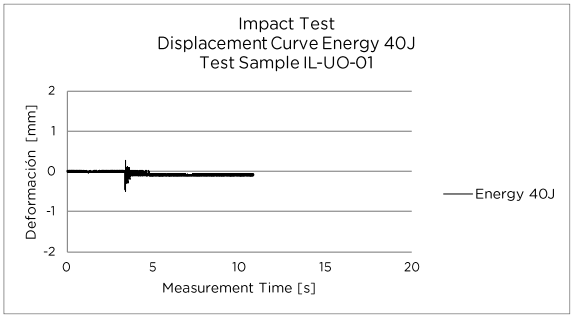
The results are presented through behavior curves, instantaneous deformation curves and results tables with the respective damage observations.

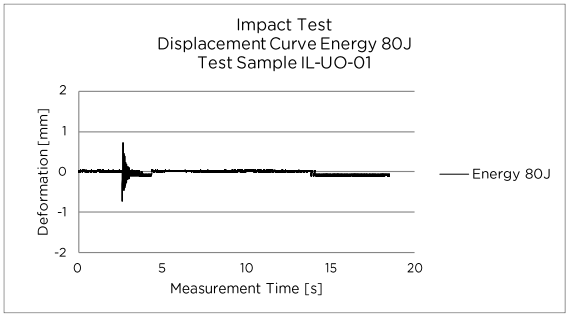
The following graphics show the behavior curves for instantaneous and residual deformations. From Figure 7.4.2.1 to Figure 7.4.2.3, the instantaneous deformation curves obtained for specimen impacts are shown, which are presented in groups of 6 graphs for each specimen, corresponding to the impact energy levels. Finally, from Table 7.4.2.1 to 7.4.2.3, a summary of the results obtained together with the perceived damage is presented.

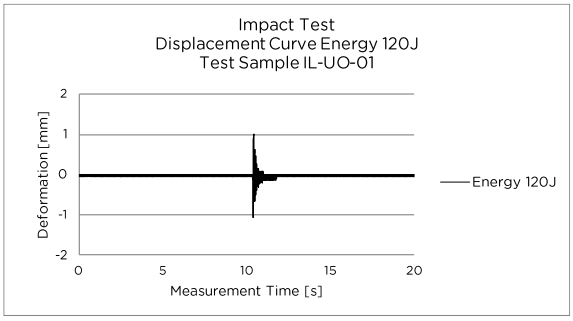
- Test Sample Results IL–UO–01

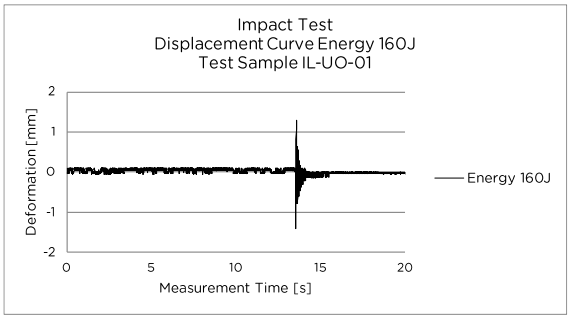



Graphic 7.4.2.1. Behavior curve. Test Sample IL–UO–01.



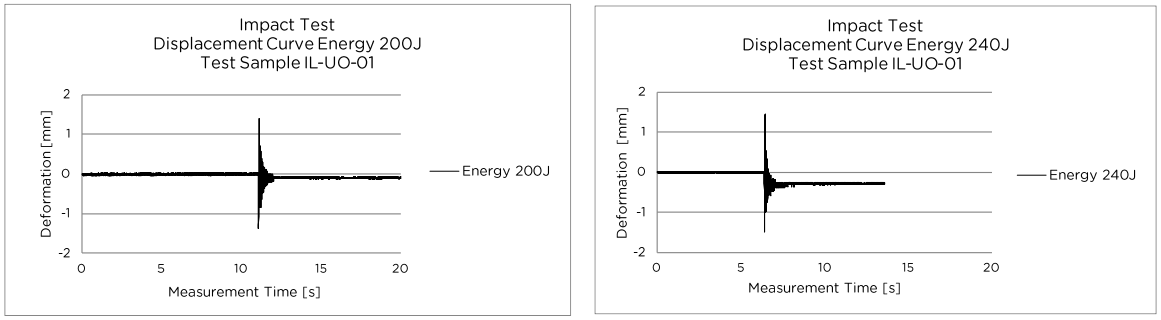



Figure 7.4.2.1. Displacement curves. Test Sample IL–UO-01.

Table 7.4.2.1. Impact Test Results. Test Sample IL–UO-01.

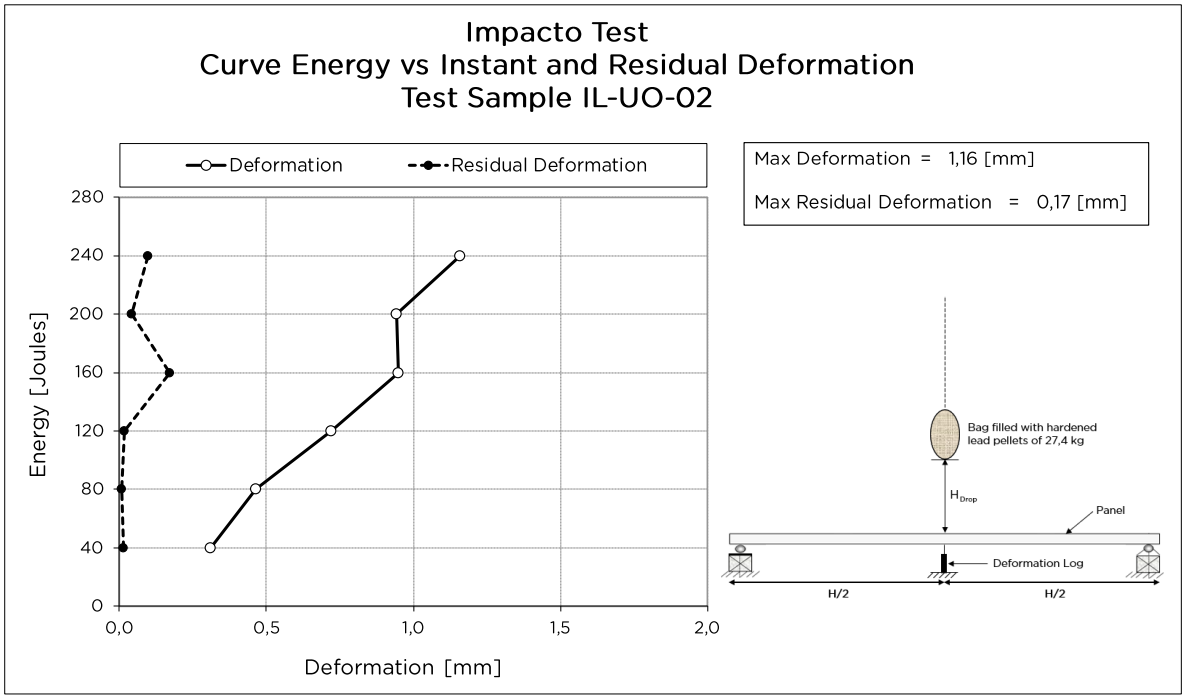
| Energy[1] [Joules] | Maximum Deformation [mm] | Residual Deformation [mm] | Normative Compliance. Residual Def. Criteria | Observations | Normative Compliance. Damage Criteria |
|---|---|---|---|---|---|
| 40 | 0,48 | 0,07 | Meet | No damage | Meet |
| 80 | 0,73 | 0,07 | Meet | No damage | Meet |
| 120 | 1,06 | 0,00 | Meet | No damage | Meet |
| 160 | 1,40 | 0,04 | Meet | No damage | Meet |
| 200 | 1,40 | 0,08 | Meet | No damage | Meet |
| 240 | 1,49 | 0,28 | Meet | No damage | Meet |

(1) Calculated as $m \cdot g \cdot h$, where $m$ is the weight of the leather bag (27,4 kg.), $g$ is the gravity acceleration (9,81 m/s$^2$) and $h$ is the bag drop height in meters.

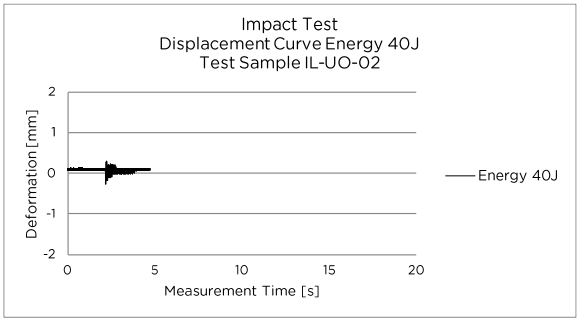
Regarding Table 7.4.2.1, according to the requirements established in Nch806:2022, section 7.5, the residual deformation in the elastic zone must not exceed 30% of the deformation under impact (maximum instantaneous deformation). In addition, it establishes, respect to damage, that for an energy value of 120 J no apparent damage or deterioration should be observed and for 240 J there should be no breakage of the panel. For this specimen all conditions are met, specifically, it was considered that the core of the panel did not experience rupture as it preserved its structural integrity for an energy impact of 240 J.

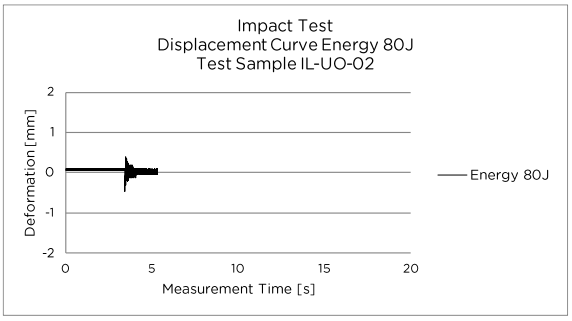
No damage was observed associated with the IL-UO-01 specimen.

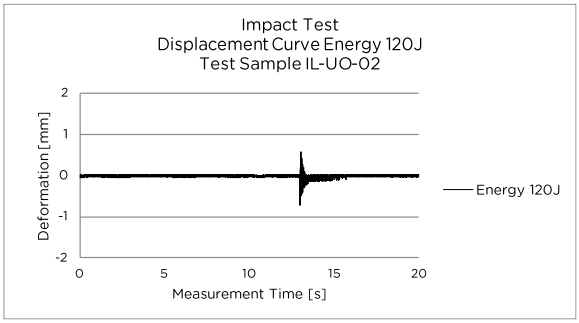
- Test Sample Results IL–UO–02

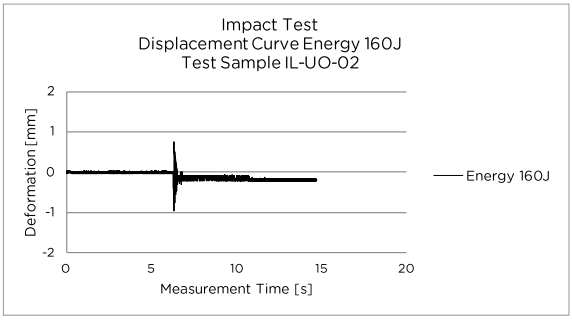



Graphic 7.4.2.2. Behavior curve. Test Sample IL–UO-02.



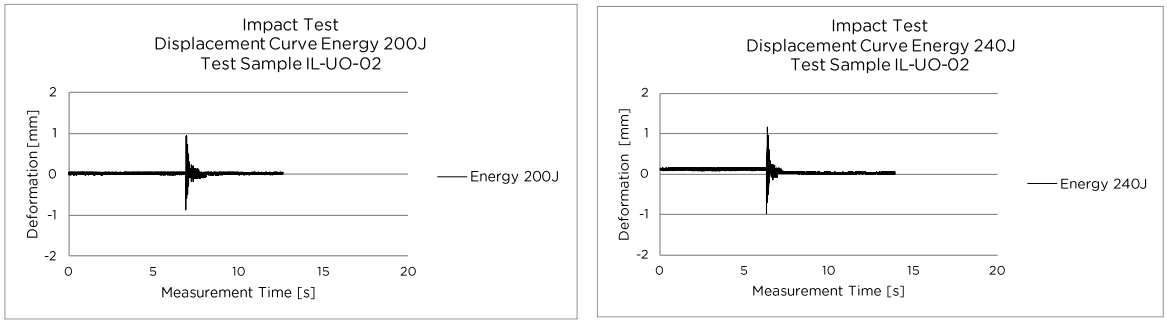



Figure 7.4.2.2. Displacement curves. Test Sample IL–UO-02.

Table 7.4.2.2. Impact Test Results. Test Sample IL–UO-02.

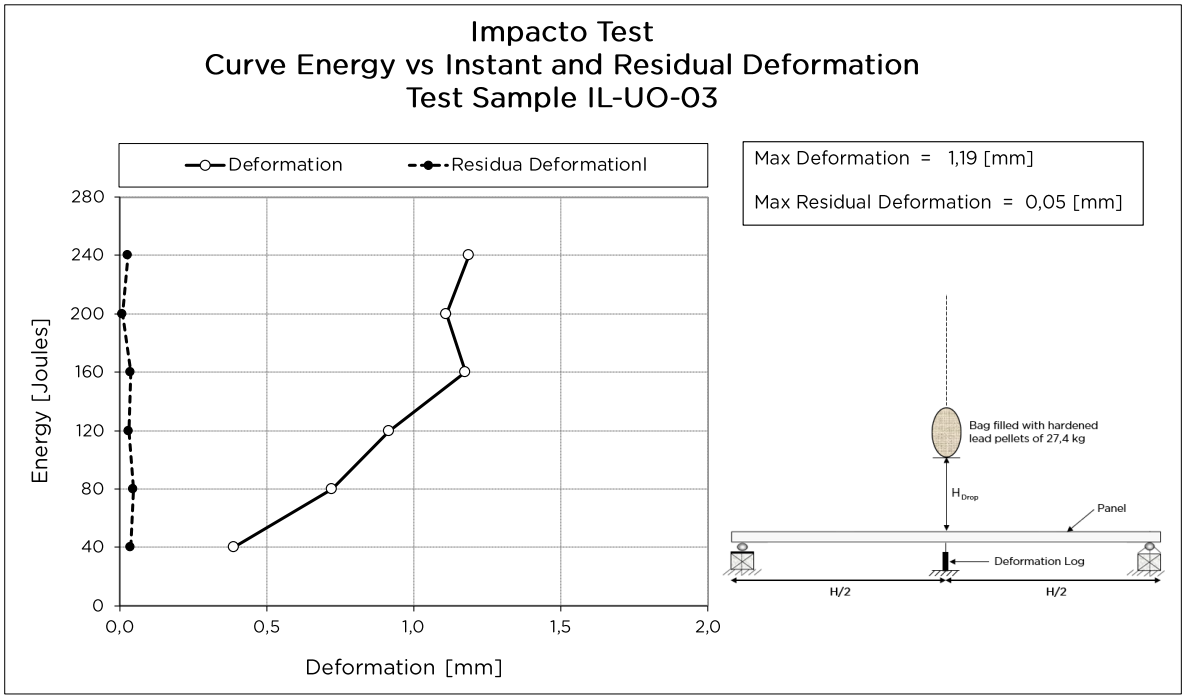
| Energy[1] [Joules] | Maximum Deformation [mm] | Residual Deformation [mm] | Normative Compliance. Residual Def. Criteria | Observations | Normative Compliance. Damage Criteria |
|---|---|---|---|---|---|
| 40 | 0,31 | 0,01 | Meet | No damage | Meet |
| 80 | 0,46 | 0,01 | Meet | No damage | Meet |
| 120 | 0,72 | 0,02 | Meet | No damage | Meet |
| 160 | 0,95 | 0,17 | Meet | No damage | Meet |
| 200 | 0,94 | 0,04 | Meet | No damage | Meet |
| 240 | 1,16 | 0,10 | Meet | No damage | Meet |

(1) Calculated as $m \cdot g \cdot h$, where $m$ is the weight of the leather bag (27,4 kg.), $g$ is the gravity acceleration (9,81 m/s$^2$) and $h$ is the bag drop height in meters.

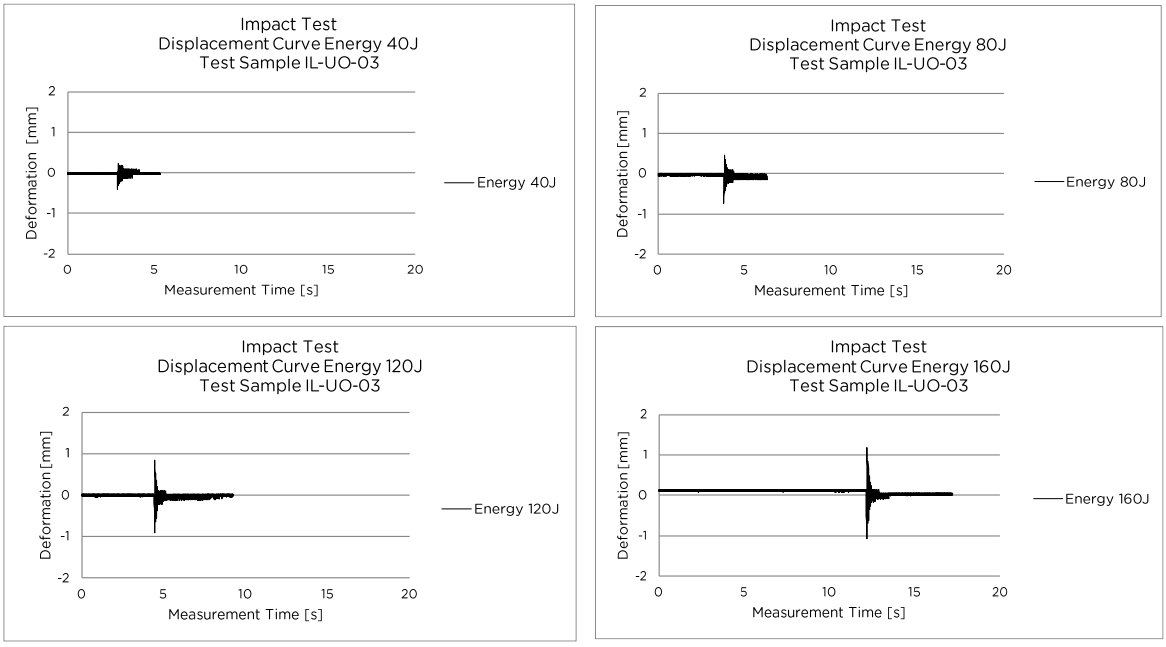
In Table 7.4.2.2, the deformation and damage criteria stipulated in Nch806:2022, section 7.5, which were mentioned in the test IL-UO-01, are also met.

No damage was observed associated with the IL-UO-02 specimen.

- Test Sample Results IL–UO–03




Graphic 7.4.2.3. Behavior curve. Test Sample IL–UO-03.



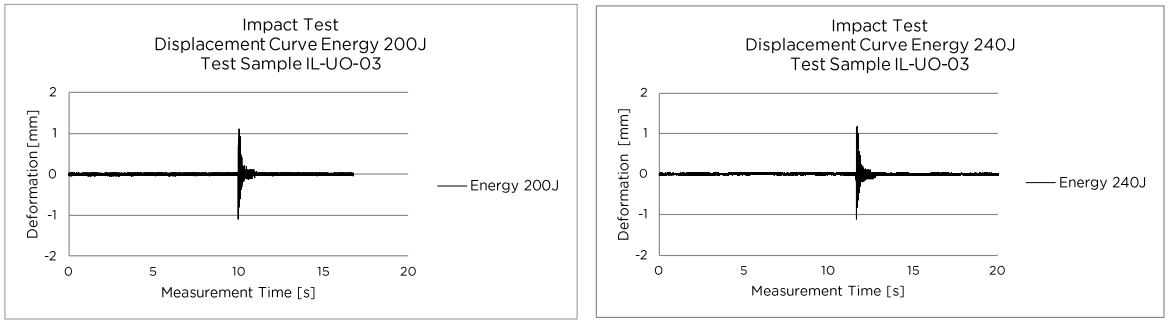



Figure 7.4.2.3. Displacement curves. Test Sample IL–UO-03.

Table 7.4.2.3. Impact Test Results. Test Sample IL–UO-03.

| Energy[1] [Joules] | Maximum Deformation [mm] | Residual Deformation [mm] | Normative Compliance. Residual Def. Criteria | Observations | Normative Compliance. Damage Criteria |
|---|---|---|---|---|---|
| 40 | 0,39 | 0,04 | Meet | No damage | Meet |
| 80 | 0,72 | 0,05 | Meet | No damage | Meet |
| 120 | 0,92 | 0,03 | Meet | No damage | Meet |
| 160 | 1,18 | 0,04 | Meet | No damage | Meet |
| 200 | 1,11 | 0,01 | Meet | No damage | Meet |
| 240 | 1,19 | 0,03 | Meet | No damage | Meet |

(1) Calculated as $m \cdot g \cdot h$, where $m$ is the weight of the leather bag (27,4 kg.), $g$ is the gravity acceleration (9,81 m/s$^2$) and $h$ is the bag drop height in meters.

In Table 7.4.2.3, the deformation and damage criteria stipulated in Nch806:2022, section 7.5, which were mentioned in the test IL-UO-01, are also met.

No damage was observed associated with the IL-UO-03 specimen.

# 8 Executive Summary and/or Conclusions

The tests were performed at the request of Mr. Sanjay Bowry on behalf of the company Eco Buildings Group, under the acceptance of the work proposal LIE-23-121-00, associated to Ticket 42287.

Below are summary tables with the results of the compression, shear, bending and impact tests performed on prefabricated gypsum and fiberglass composite panels with the presence of transverse cavities that are filled with concrete at the work site.

## 8.1 Compression Test

Table 8.1.1 shows the results obtained from the compression tests.

**Table 8.1.1. Characteristic values for compression tests.**

| Test Sample | Pmax[1] [kN/m] | δmax Vertical[2] [mm] | δmax Lateral[3] [mm] |
|---|---|---|---|
| VL-UO-01 | 286,20 | 0,00062 | 1,38 |
| VL-UO-02 | 285,62 | 0,00065 | 1,96 |
| VL-UO-03 | 286,79 | 0,00045 | 1,38 |
| **Average** | 286,20 | 0,00057 | 1,57 |
| **Standard Dev.** | 0,59 | 0,00011 | 0,34 |

According to NCh801:2016, the representative load of the system, corresponding to the lowest load, for the compressive load of the construction system is: **285.62 [kN/m].**

## 8.2 Shear Test

Table 8.2.1 shows the values obtained from the shear tests.

**Table 8.2.1. Characteristic values for the shear tests.**

| Test Sample | Vmax[1] [kN/m] | δmax[2] [mm] | K elast[3] [kgf/mm] |
|---|---|---|---|
| HL-UO-01 | 83,51 | 7,50 | 5172 |
| HL-UO-02 | 76,89 | 7,59 | 5224 |
| HL-UO-03 | 68,64 | 4,54 | 4976 |
| **Average** | 76,35 | 6,54 | 5124 |
| **Standard Dev.** | 7,45 | 1,73 | 131 |

According to NCh802:2017, the representative load for the horizontal load of the construction system corresponds to the lowest obtained and is: **68,64 kN/m**.

## 8.3 Bending Test

Table 8.3.1 shows the values obtained from the bending tests.

Table 8.3.1. Characteristic values for the bending tests.

| Test Sample | Pmax[1] [kN/m] | δmax[2] [mm] | Mmax[3] [kN·m/m] | K elast[4] [kgf/mm] |
|---|---|---|---|---|
| TL-UO-01 | 30,38 | 58,58 | 10,53 | 459 |
| TL-UO-02 | 35,16 | 51,23 | 11,92 | 431 |
| TL-UO-03 | 28,74 | 65,91 | 10,09 | 507 |
| **Average** | 31,43 | 58,57 | 10,85 | 466 |
| **Standard Dev.** | 3,33 | 7,34 | 0,96 | 39 |

According to NCh803:2016 the representative load, i.e., the lowest, for the bending load of the construction system is: **28.74 [kN/m]**, with an associated bending moment of **10.09 [KN-m/m]**.

## 8.4 Impact Test

For the impact tests, the results are shown in Tables 8.4.1 to 8.4.3.

Table 8.4.1. Characteristic values for the impact tests. Test Sample IL-UO-01.

| Bag Drop Height (H) [cm] | Energy[1] [Joules] | Maximum Deformation [mm] | Residual Deformation [mm] | Observations |
|---|---|---|---|---|
| 15 | 40 | 0,48 | 0,07 | No damage |
| 30 | 80 | 0,73 | 0,07 | No damage |
| 45 | 120 | 1,06 | 0,00 | No damage |
| 60 | 160 | 1,40 | 0,04 | No damage |
| 75 | 200 | 1,40 | 0,08 | No damage |
| 90 | 240 | 1,49 | 0,28 | No damage |

Table 8.4.2. Characteristic values for the impact tests. Test Sample IL-UO-02.

| Bag Drop Height (H) [cm] | Energy[1] [Joules] | Maximum Deformation [mm] | Residual Deformation [mm] | Observations |
|---|---|---|---|---|
| 15 | 40 | 0,31 | 0,01 | No damage |
| 30 | 80 | 0,46 | 0,01 | No damage |
| 45 | 120 | 0,72 | 0,02 | No damage |
| 60 | 160 | 0,95 | 0,17 | No damage |
| 75 | 200 | 0,94 | 0,04 | No damage |
| 90 | 240 | 1,16 | 0,10 | No damage |

Table 8.4.3. Characteristic values for the impact tests. Test Sample IL-UO-03.

| Bag Drop Height (H) [cm] | Energy[1] [Joules] | Maximum Deformation [mm] | Residual Deformation [mm] | Observations |
|---|---|---|---|---|
| 15 | 40 | 0,39 | 0,04 | No damage |
| 30 | 80 | 0,72 | 0,05 | No damage |
| 45 | 120 | 0,92 | 0,03 | No damage |
| 60 | 160 | 1,18 | 0,04 | No damage |
| 75 | 200 | 1,11 | 0,01 | No damage |
| 90 | 240 | 1,19 | 0,03 | No damage |

All specimens met the criteria for residual deformation and damage associated with the energy levels. Therefore, the system complies with the requirements established in 7.5 of NCh806:2022 for the impact test.

This report refers only to the Vertical Load (Compression), Horizontal Load (Shear), Transverse Load (Bending) and Impact Load tests.

In the analysis of the construction system for each particular, all the aspects indicated in the NCh806:2022 standard for the structural evaluation of a non-traditional construction system must be considered, as well as the habitability requirements, in addition to the impact resistance.

All information on the origin and characteristics of the panels was fully provided by the client.