# EMMEDUE S.P.A.

Via Toniolo 39/B, Loc. Bellocchi, Fano (PU)

# EXPERIMENTAL TESTING UPON THE INTEGRATED SYSTEM OF EMMEDUE MODULAR PANELS

REPORT ON STATIC TESTING FOR PANELS OF REDUCED DIMENSIONS

# EUCENTRE


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| ISSUED: JUNE 2008 | Drawn up | Scale | File name |
| REVISION | RP | Draftsman | RapportoDiProva 2.doc |
| REVISION | | | Project/Protocol No. |
| REVISION | | | EUC 215/2007U |

## 1. Introduction

The company EMMEDUE, with Headquarters at No. 39/B Via Toniolo, Loc. Bellocchi, Fano (PU), which is interested in obtaining the technical pass certificate for an integrated system of modular panels which it owns the legal rights to, has engaged Eucentre to perform the activities described below:

- Static testing upon 12 panels of reduced dimensions
- Static testing upon 8 floor elements
- Testing upon 8 true scale panels in cyclic conditions
- Tests upon 4 junctions
- Pseudo-dynamic test upon a 1:1 scale building
- Evaluation of the results obtained
- Support for requesting and obtaining technical pass certification

This report has been issued in relation to the static testing performed upon 12 panels of reduced dimensions.

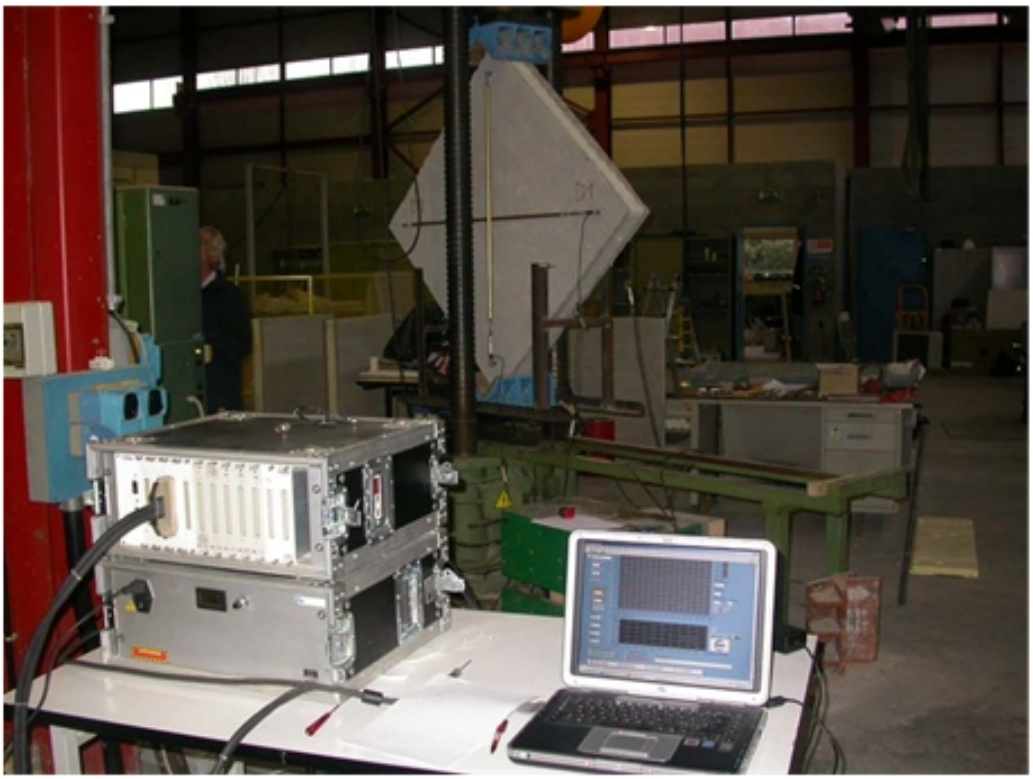


Figure 1: Testing station

## 2. Description of the tests

The tests were performed at the Materials and Structures Testing Laboratories of the Università degli Studi di Pavia.

The testing campaign is made up of near static tests upon the following panels:

| Test No. | Dimensions [m] | Thickness [mm] | Polystyrene thickness [kg/m$^3$] | Test type |
|---|---|---|---|---|
| C1 | 1.13 x 1.13 | 35+80+35 | 15 | Compression |
| C2 | 1.13 x 1.13 | 35+80+35 | 15 | Compression |
| C3 | 0.60 x 1.13 | 35+140+35 | 15 | Compression |
| C4 | 0.60 x 1.13 | 35+140+35 | 15 | Compression |
| C5 | 1.13 x 1.13 | 35+80+35 | 25 | Compression |
| C6 | 0.60 x 1.13 | 35+80+35 | 25 | Compression |
| D1 | 1.13 x 1.13 | 35+80+35 | 15 | Shearing |
| D2 | 1.13 x 1.13 | 35+80+35 | 15 | Shearing |
| E1 | 1.13 x 1.13 | 35+80+35 | 15 | Ecc. Compr. |
| E2 | 1.13 x 1.13 | 35+80+35 | 15 | Ecc. Compr. |
| De1 | 1.13 x 1.13 | 35+80+35 | 15 | Delamination |
| De2 | 1.13 x 1.13 | 35+80+35 | 15 | Delamination |

For the application of the load, a class 01 AMSLER press capable of applying a maximum load of 200 tons was employed.

### 2.1 Compression testing

For the compression testing, after having smoothed the panel in order to normalize the support surface, the load was applied in a uniform manner.

Figure 2: Compression test

## 2.2 Shear testing

Angular supports, inclined at 45°, were employed for the shear testing.


Figure 3: Shear test

2.3 Eccentric Compression testing

For the eccentric compression testing, after having smoothed the panel in order to normalize the support surface, the load was only applied to half the thickness.

Figure 4: Eccentric compression test

2.4 Delamination testing

For the delamination testing, a testing station was realized, shown in figure 5 below, in order to apply the load exclusively to a single layer of concrete and to check the other layer, thereby allowing the polystyrene to slide.

Figure 5: Delamination test

## 3. Description of the instrumentation

The National Instruments data acquisition system is made up of a 24bit resolution analogical digital converter with a maximum sampling rate of 300kS, assembled with an SCXI1001 chassis multiplexer with SCXI1102B acquisition modules for potentiometers and thermocouples.

PZ-12-A-50 Gefran Rectilinear position transducers with the following technical data were employed:

| | |
|---|---|
| Useful Electrical Stroke (C.E.U.) | 50 mm |
| Theoretical Electrical Stroke (C.E.T.) | 51 mm |
| Mechanical Stroke (C.M.) | 55 mm |
| Resistance (on the C.E.T.) | 2 k• |
| Independent Linearity (within the C.E.U.) | +/- 0.1% |
| Dissipation at 40°C (0W at 120°C) | 1 W |
| Movement speed | • 10 m/s |
| Movement force | • 0.5 N |
| Maximum applicable voltage | 40 V |

The acquisition software was produced by the laboratory in a Labview programming environment (Figure 6).

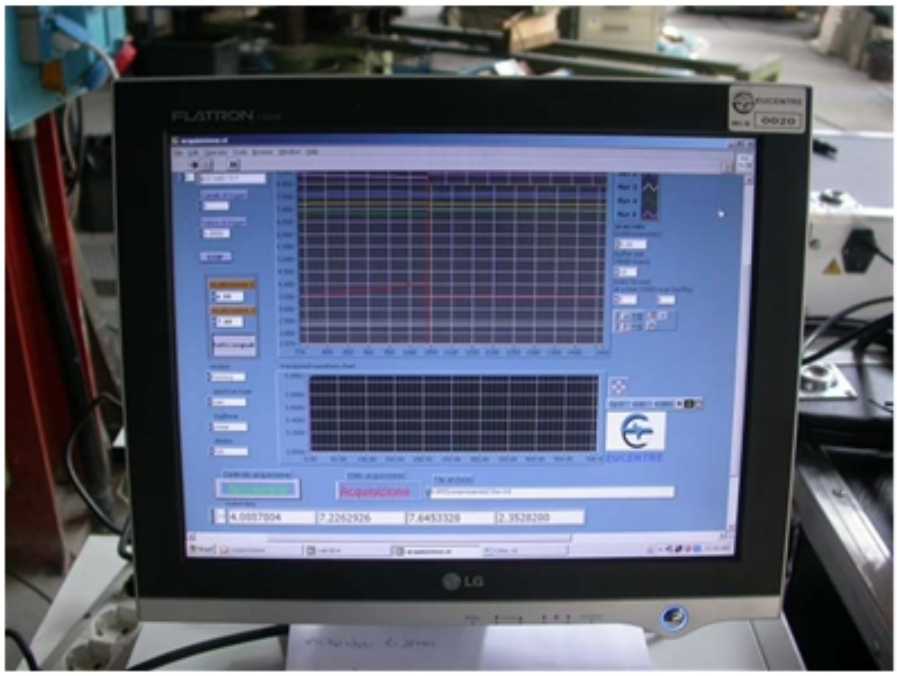


Figure 6: Data Acquisition program screenshot

3.1 Compression testing

The instrumentation was made up of 2 vertical potentiometers and 1 horizontal potentiometer for each side of the sample, arranged as shown in the following figure.

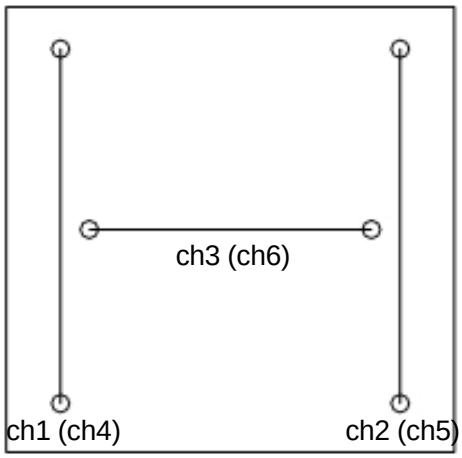



Figure 7: 2.1 Compression testing instrumentation

Panels C1, C2 and C5 base measurement lengths: ch1, ch4, ch2, ch5 L=90 cm, ch3 and ch6 L=80 cm
Panels C3, C4 and C6 base measurement lengths: ch1, ch4, ch2, ch5 L=90 cm, ch3 and ch6 L=28 cm

3.2 Shear testing

The instrumentation was made up of 2 vertical potentiometers and 1 horizontal potentiometer for each side of the sample, arranged as shown in the following figure.

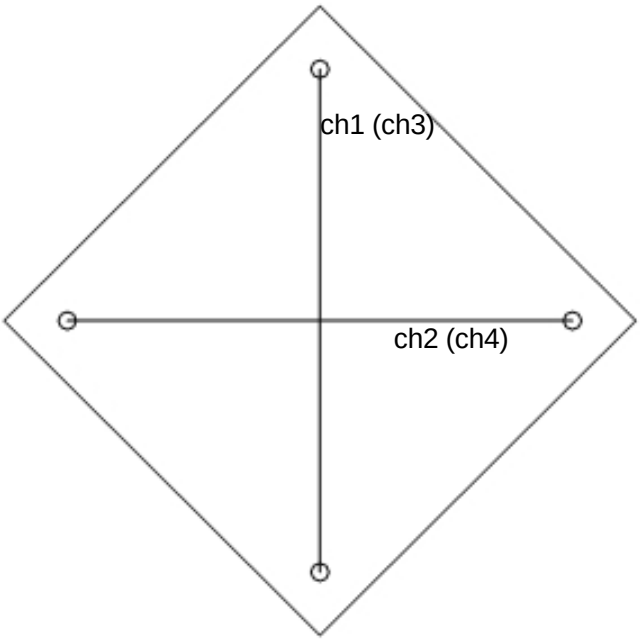



Figure 8: 2.1 Shear testing instrumentation

Base measurement lengths: ch1 and ch3 L=131.5 cm, ch2 and ch4 L=130 cm

3.3 Eccentric Compression testing

The instrumentation was made up of 2 vertical potentiometers and 1 horizontal potentiometer for each side of the sample, arranged in the same manner as the compression testing.
Base measurement lengths for panels ch1, ch4, ch2, ch5 L=90 cm, ch3 and ch6 L=80 cm

3.4 Delamination testing

The instrumentation was made up of 2 potentiometers positioned between the two layers of concrete. Base measurement lengths for the panels L=125 cm

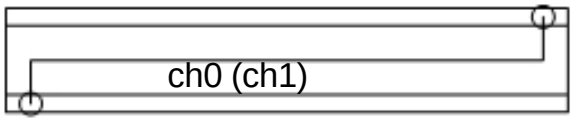



Figure 9: Delamination testing instrumentation

## 4. Description of the tested material

Emmedue offers an integrated system of modular panels whose structural functionality is guaranteed by two welded, galvanized steel nets, interconnected by means of double steel connectors, which contain a specially profiled polystyrene foam slab that is even capable of providing thermal and acoustic insulation.

In this testing campaign, the single Emmedue panel (Figure 10) was tested

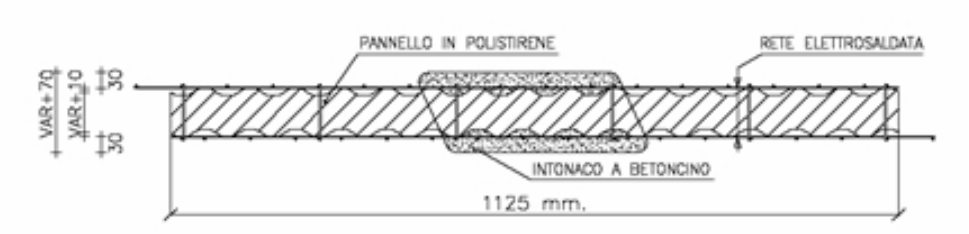



Figure 10: Single Emmedue Panel

## 5. Materials tests

Tests upon the concrete were performed in order to establish the actual characteristics of the materials. The results obtained are shown in the following table.

| Compression resistance tests on samples of concrete for M2 floors | | | | | |
|---|---|---|---|---|---|
| Packaging date | Test date | Length [mm] | Width [mm] | Height [mm] | Resistance [N/mm$^2$] |
| 17/09/07 | 05/12/07 | 40 | 40 | 80 | 49.3 |
| 17/09/07 | 05/12/07 | 40 | 40 | 80 | 49.1 |
| 17/09/07 | 05/12/07 | 40 | 40 | 80 | 43.5 |
| 17/09/07 | 05/12/07 | 40 | 40 | 80 | 47.6 |
| 17/09/07 | 05/12/07 | 40 | 40 | 80 | 49.3 |
| 17/09/07 | 05/12/07 | 40 | 40 | 80 | 48.0 |

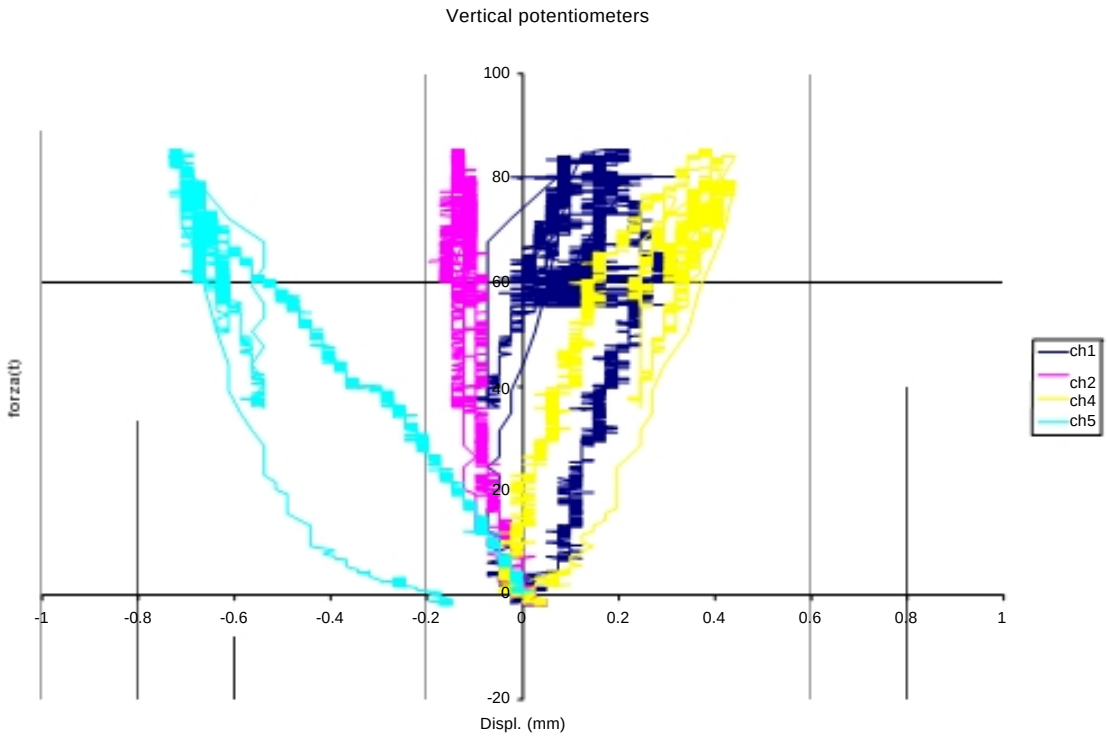
## 6. Results of the tests

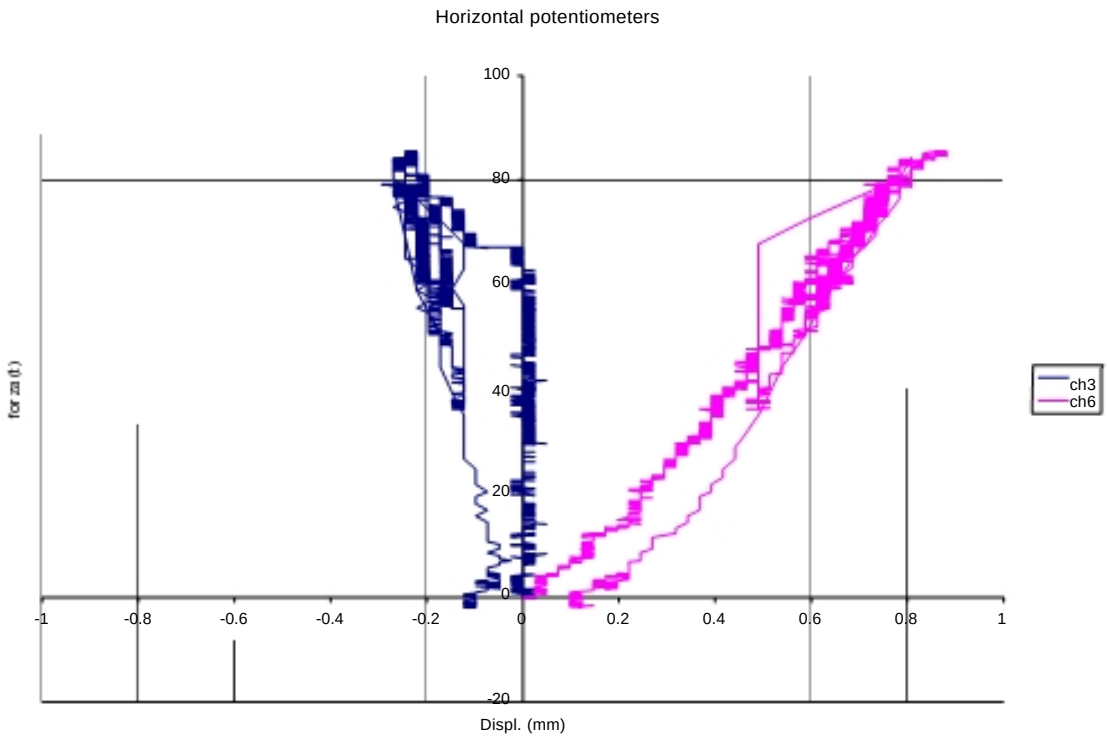
Below are listed, for each test, the force displacement diagrams of the vertical and horizontal potentiometers.

### 6.1 Compression testing

#### 6.1.1 Test C1

Test performed on 28/02/08



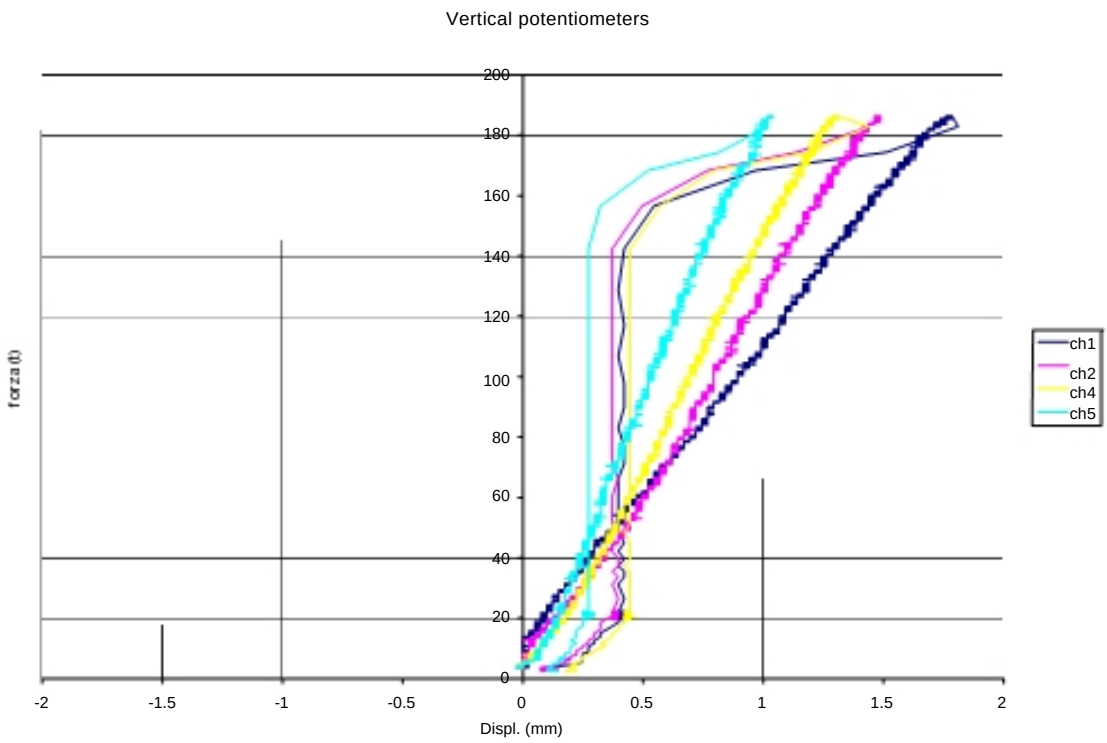
Note: Card with inverted polarity: Positive shortening, negative elongation

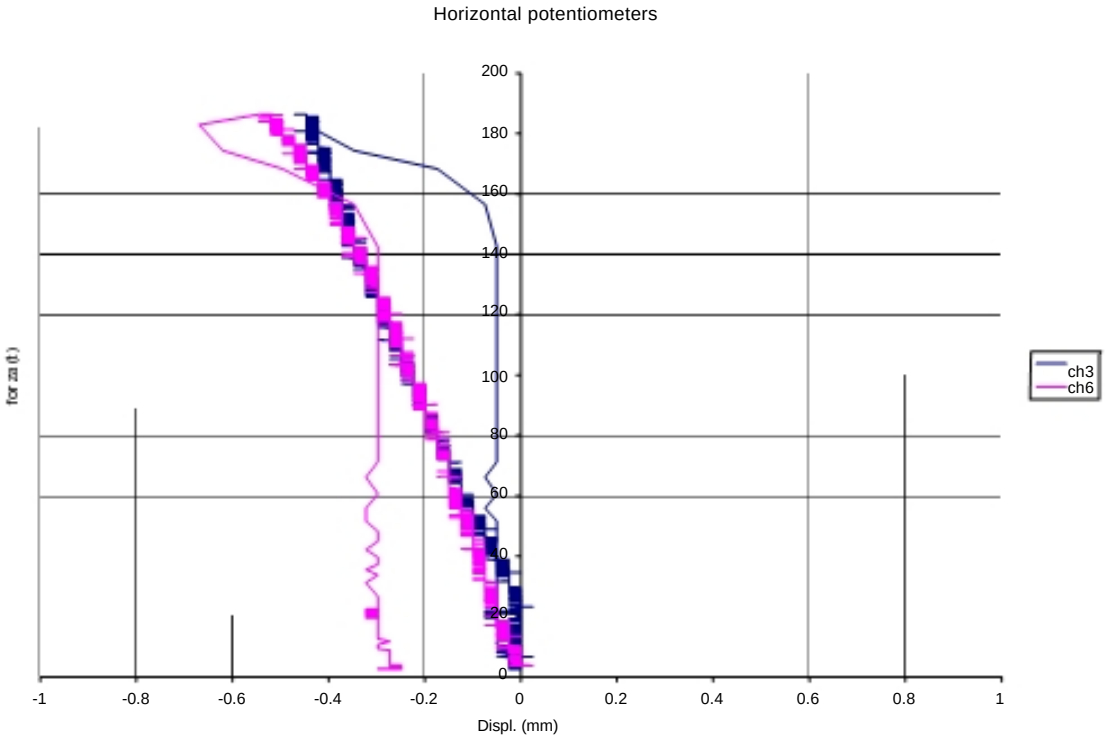
Localized breakage occurred as a result of not having performed the smoothing

Figure 11: Localized breakage

### 6.1.2 Test C2

Test performed on 05/03/08






Note: Card with inverted polarity: Positive shortening, negative elongation

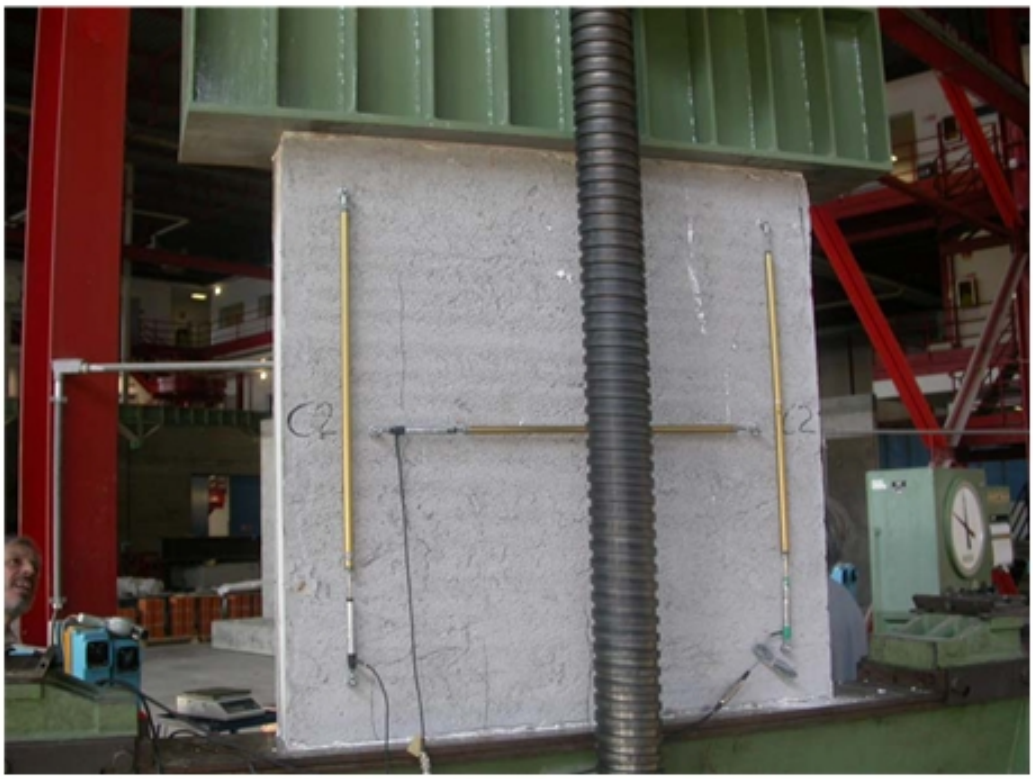
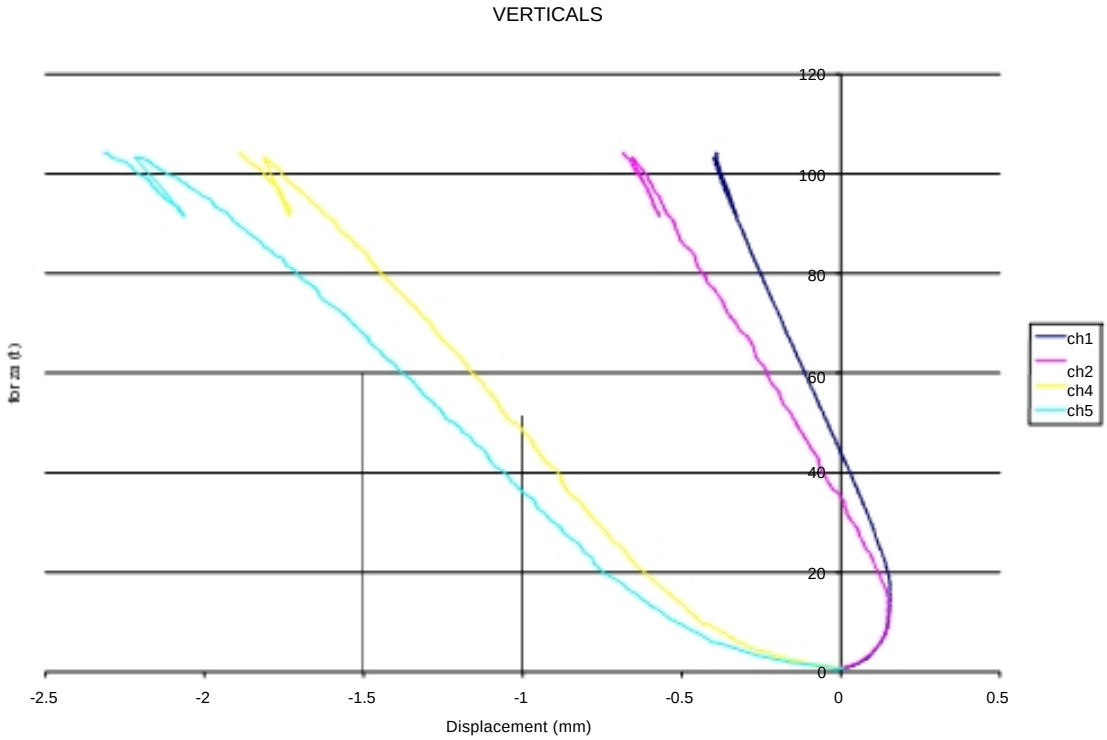


Figure 12: Edge breakage

### 6.1.3 Test C3

Test performed on 25/03/08



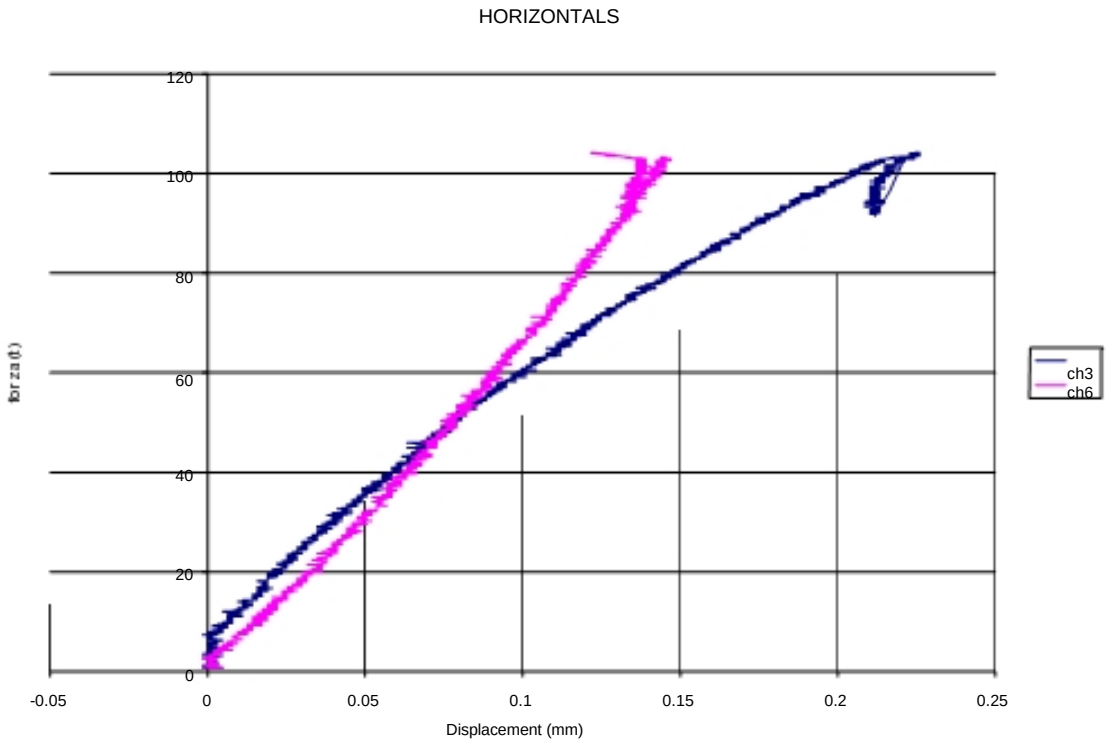
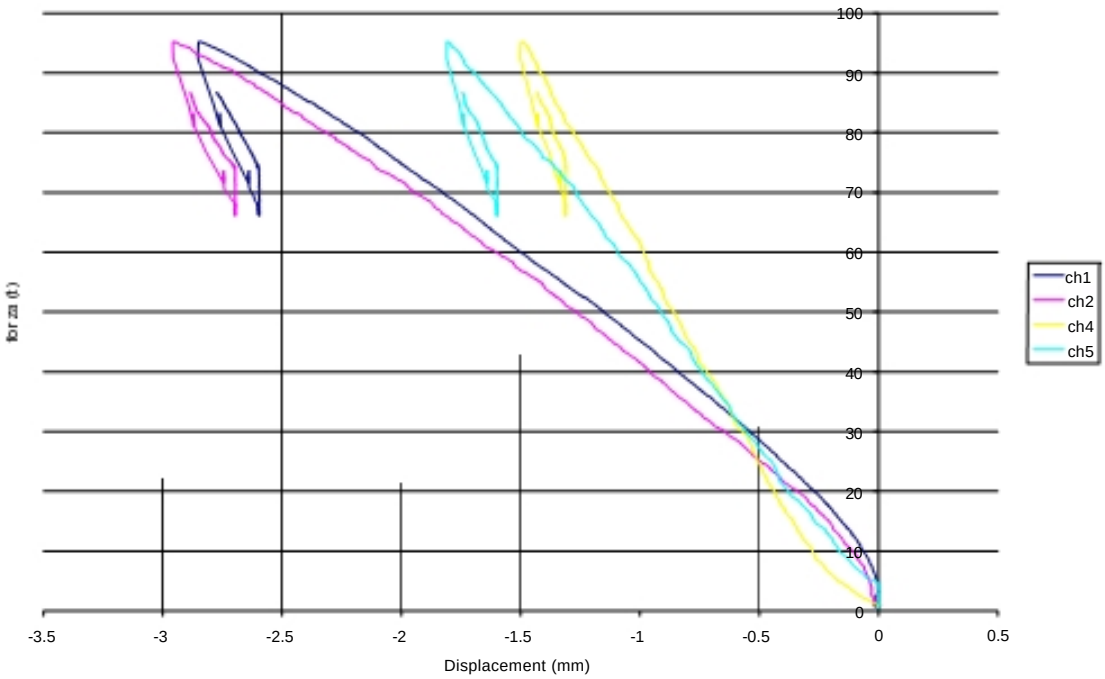



Figure 13: Breakage due to compression and flexion stresses

### 6.1.4 Test C4

Test performed on 25/03/08

VERTICALS




HORIZONTALS

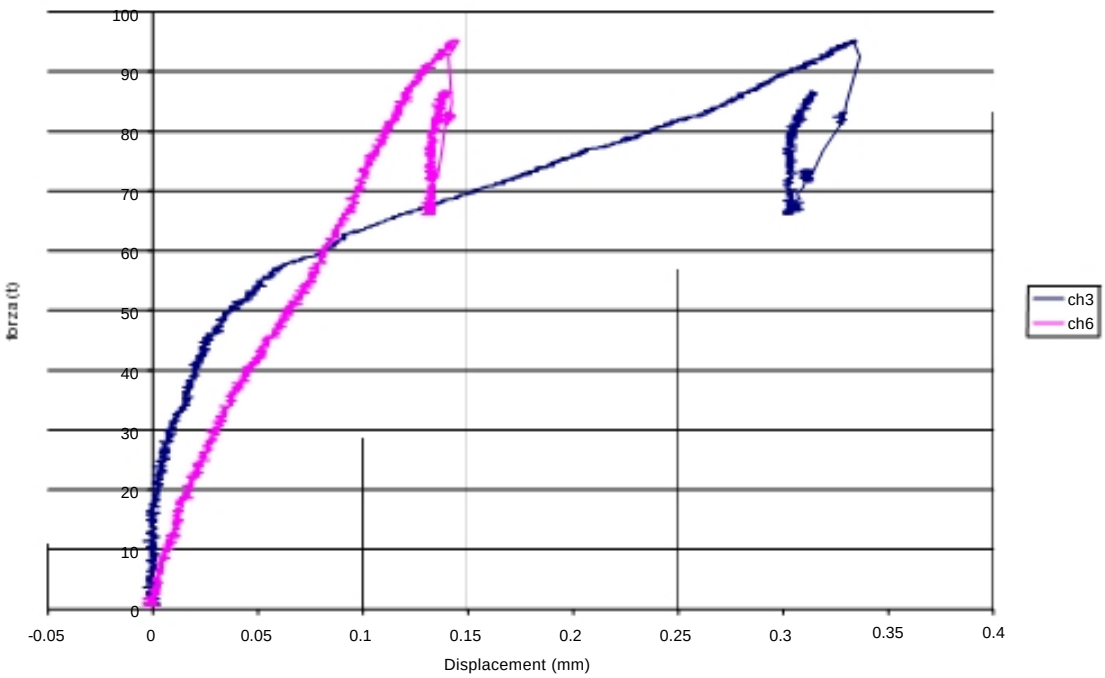
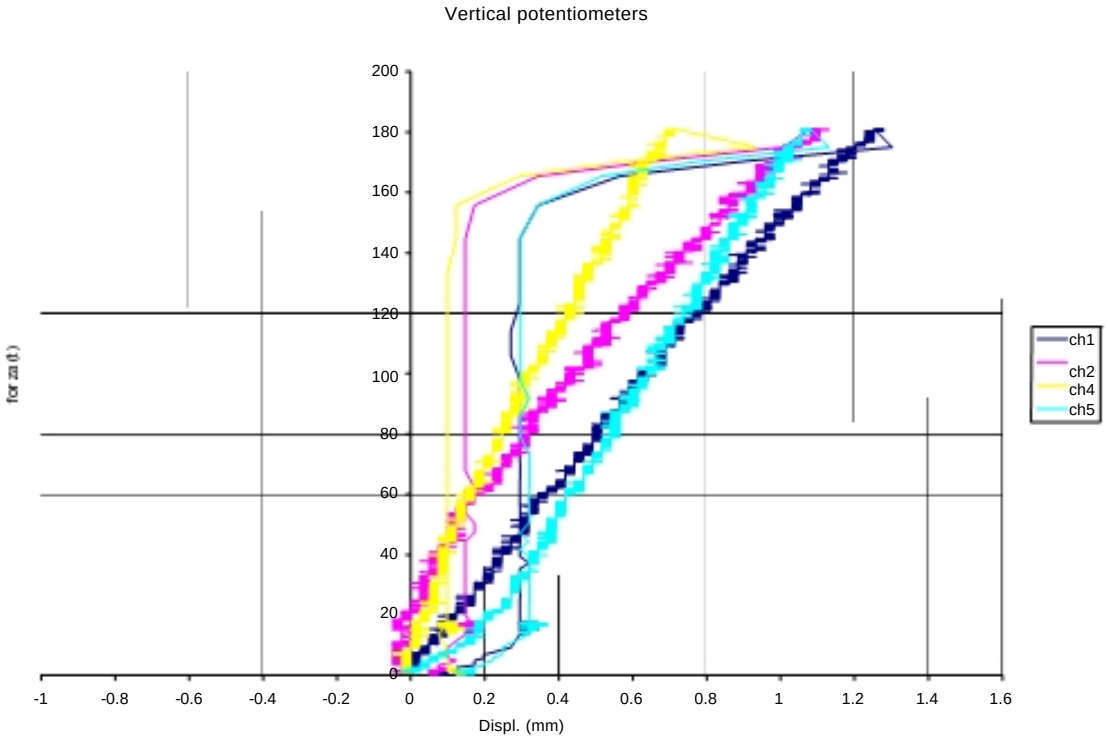


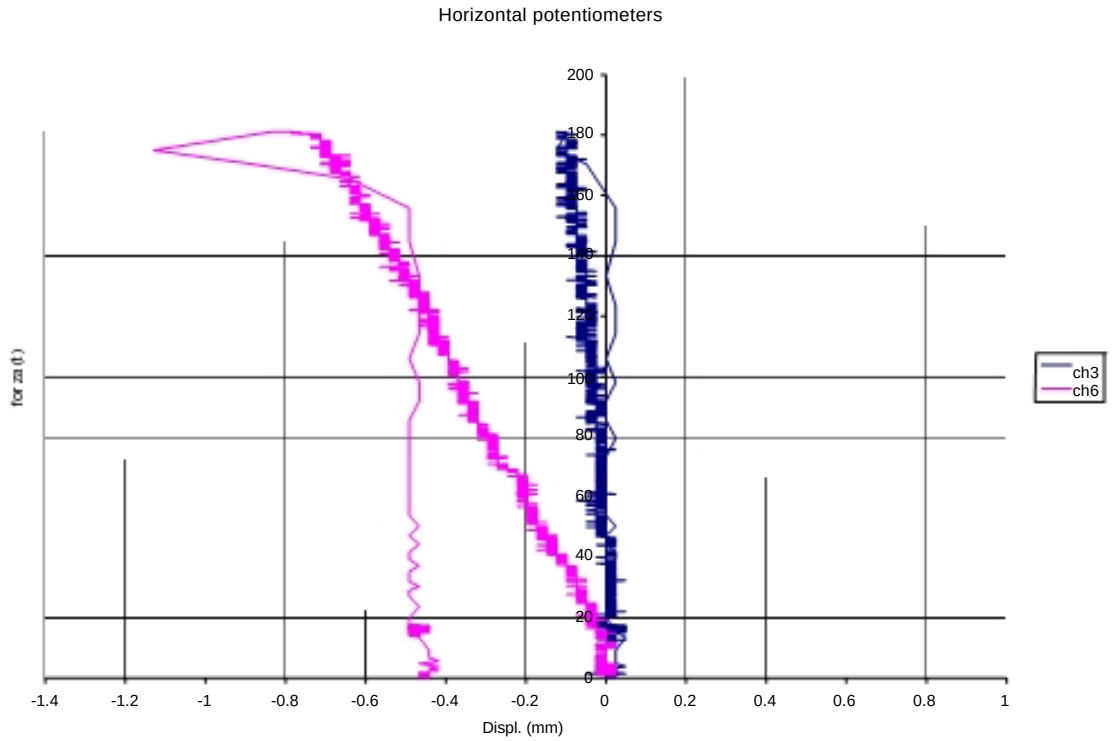

Figure 14: Panel of reduced dimensions

Figure 15: Breakage due to cement compression

### 6.1.5 Test C5

Test performed on 10/03/08

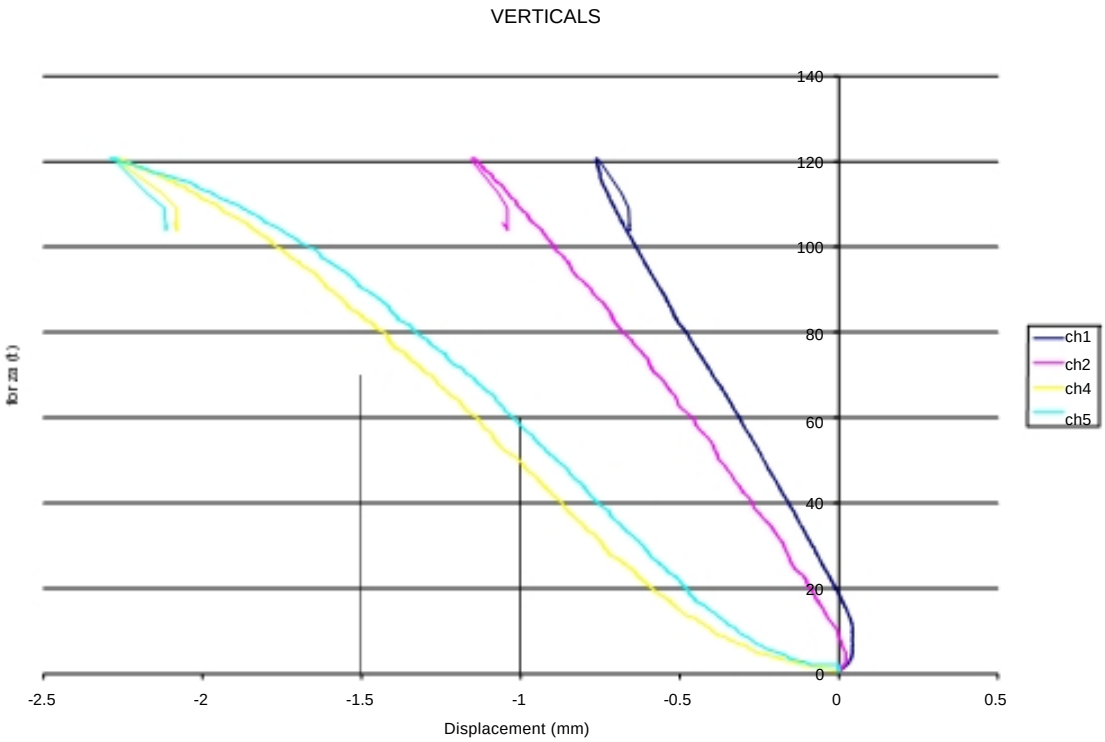



Note: Card with inverted polarity: Positive shortening, negative elongation

### 6.1.6 Test C6

Test performed on 25/03/08



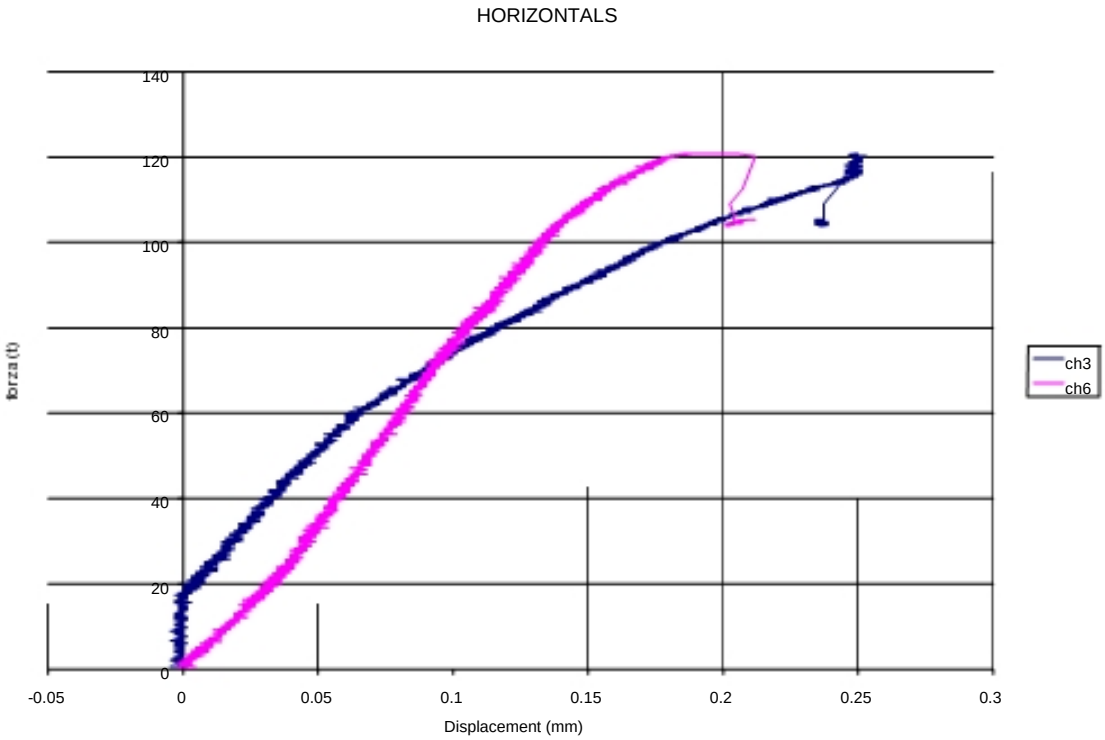



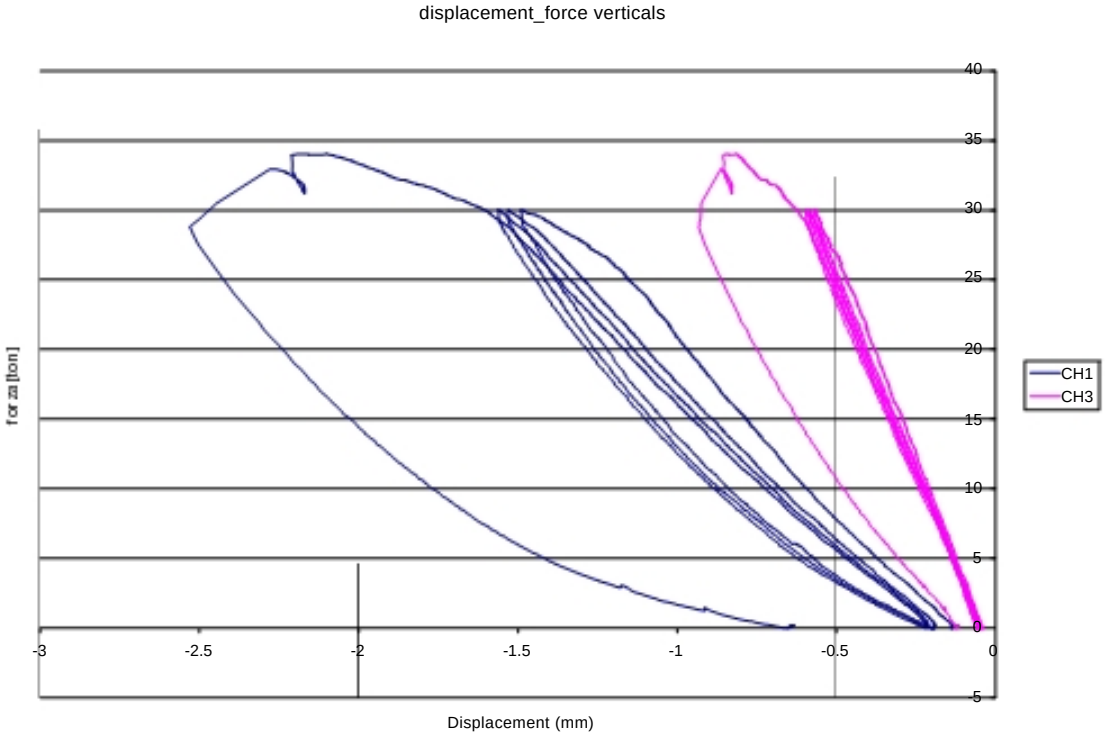
Figure 16: Destabilization of the sample

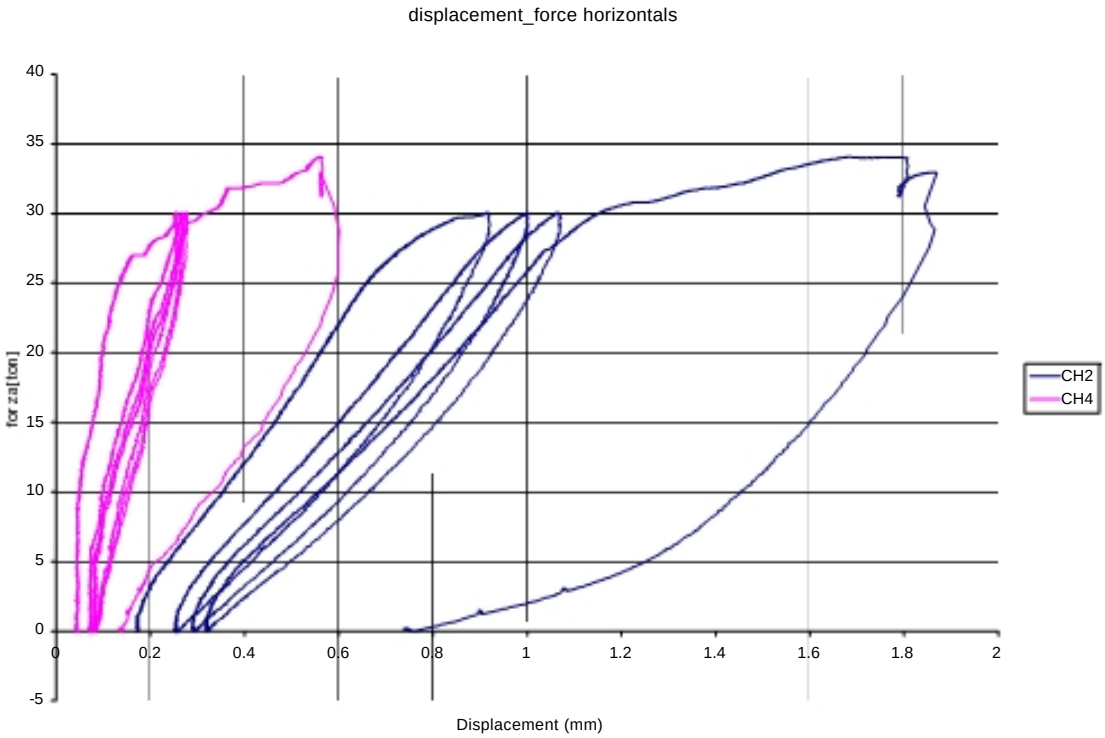
Figure 17: Destabilization of the compressed reinforcement

## 6.2 Shear testing

### 6.2.1 Test D1

Test performed on 30/01/08



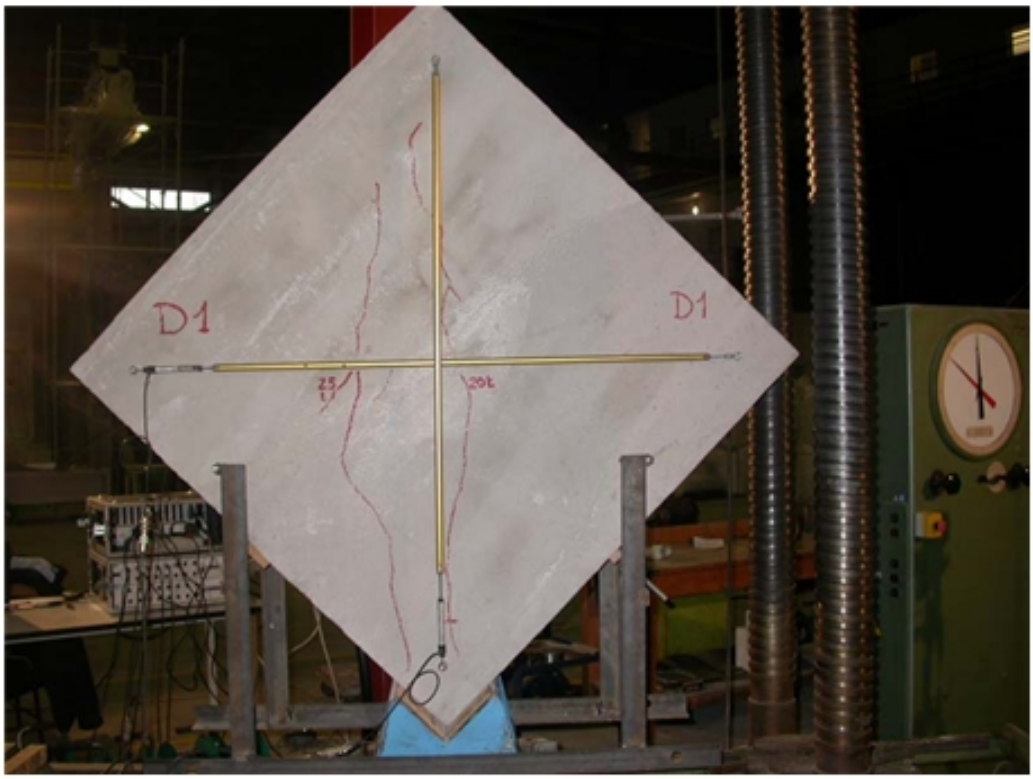
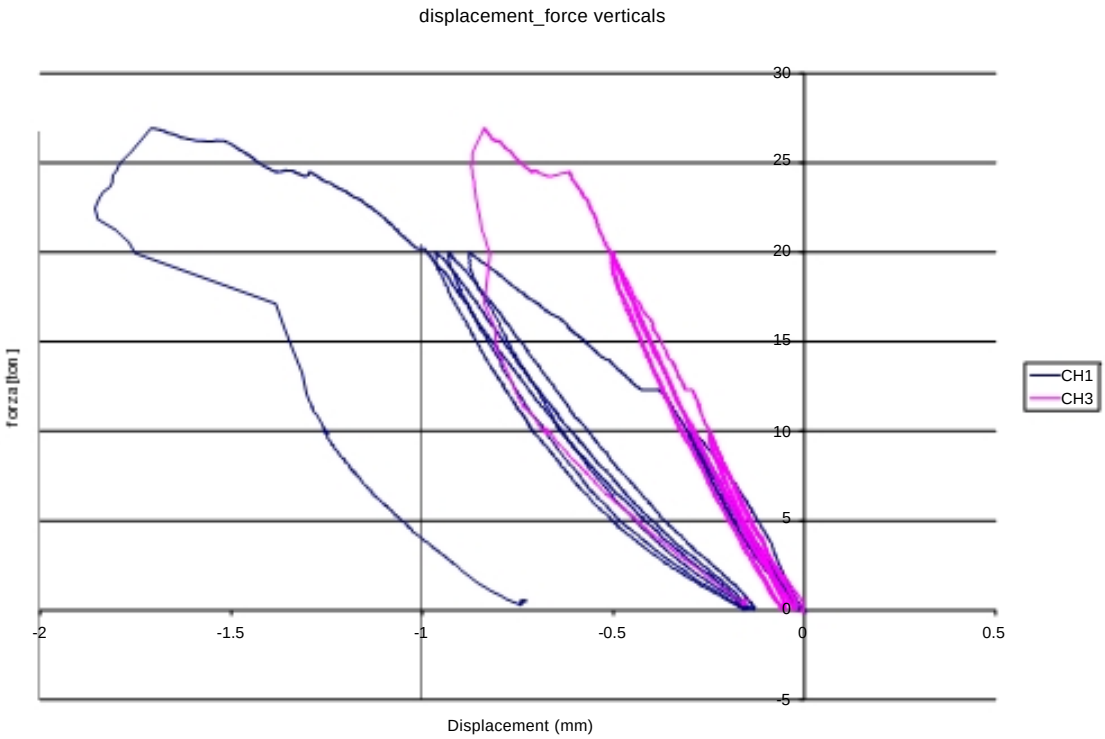
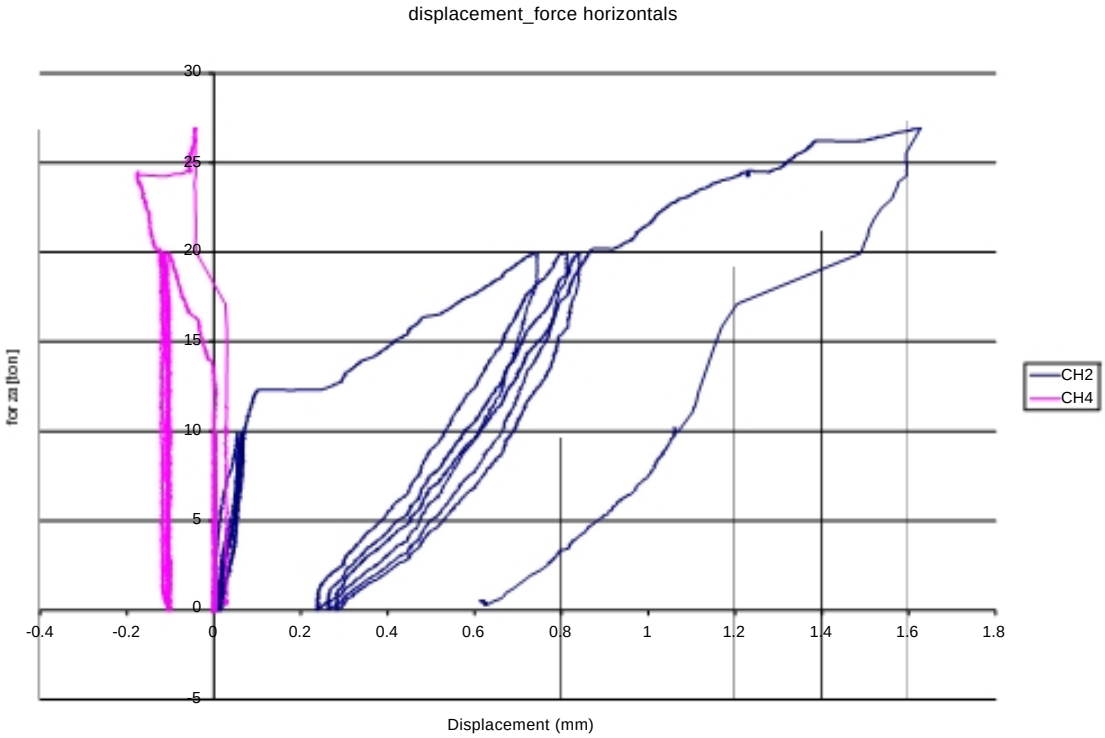



Figure 18: Fissure summary upon test completion

### 6.2.2 Test D2

Test performed on 30/01/08





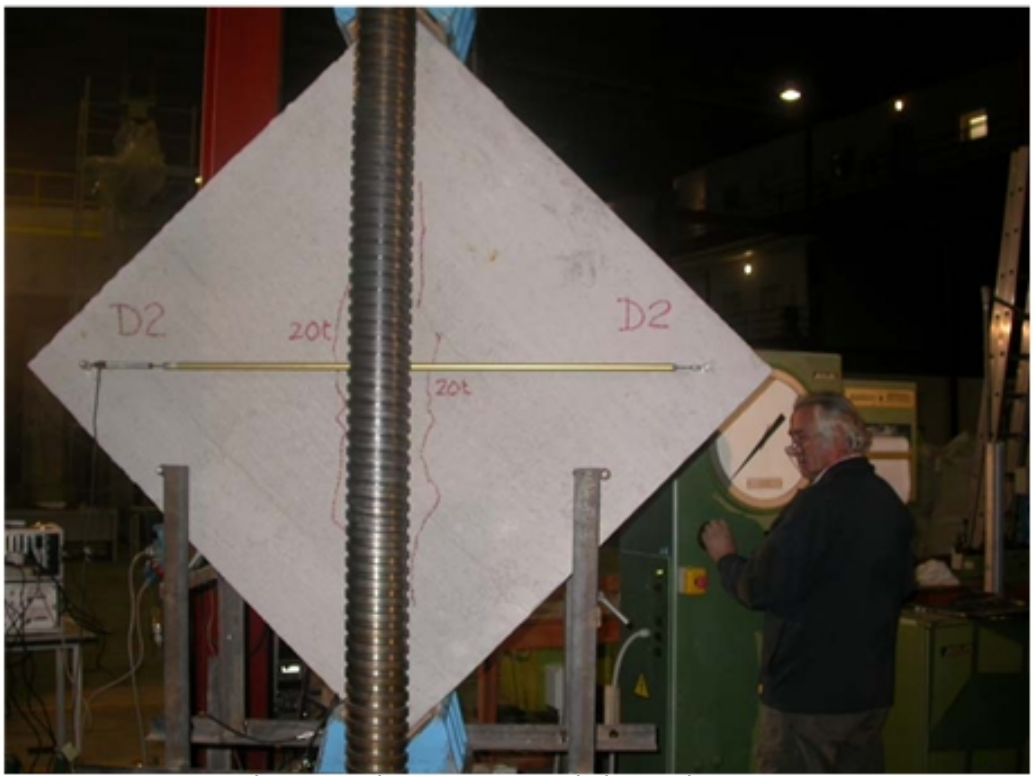



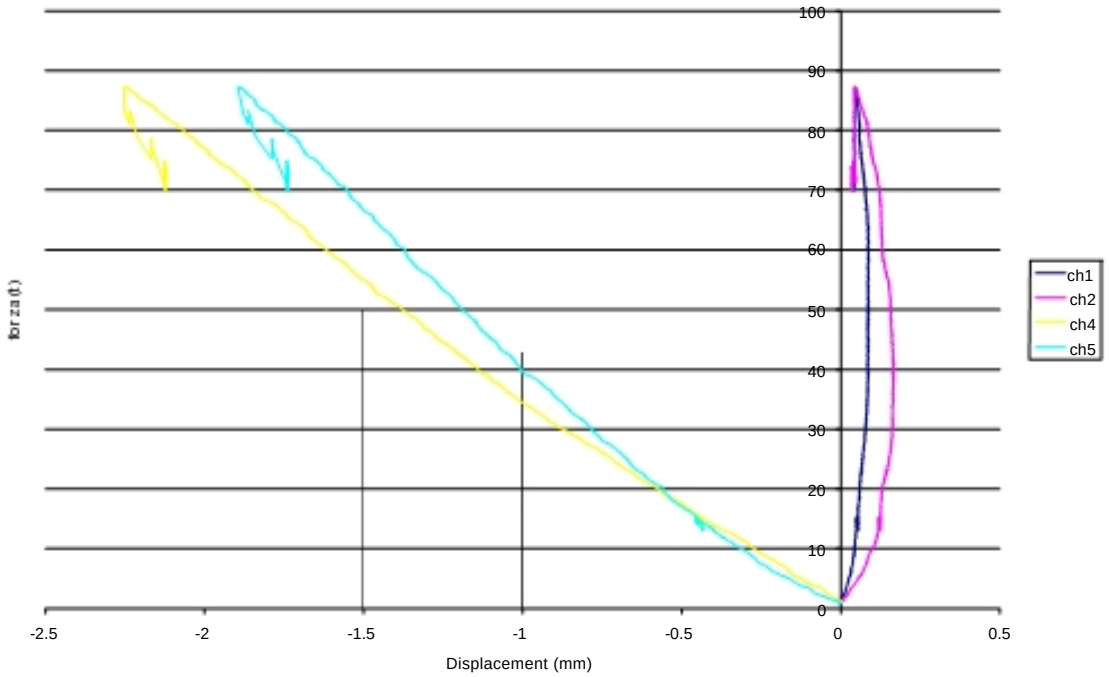

Figure 19: Fissure summary during testing

## 6.3 Eccentric Compression testing

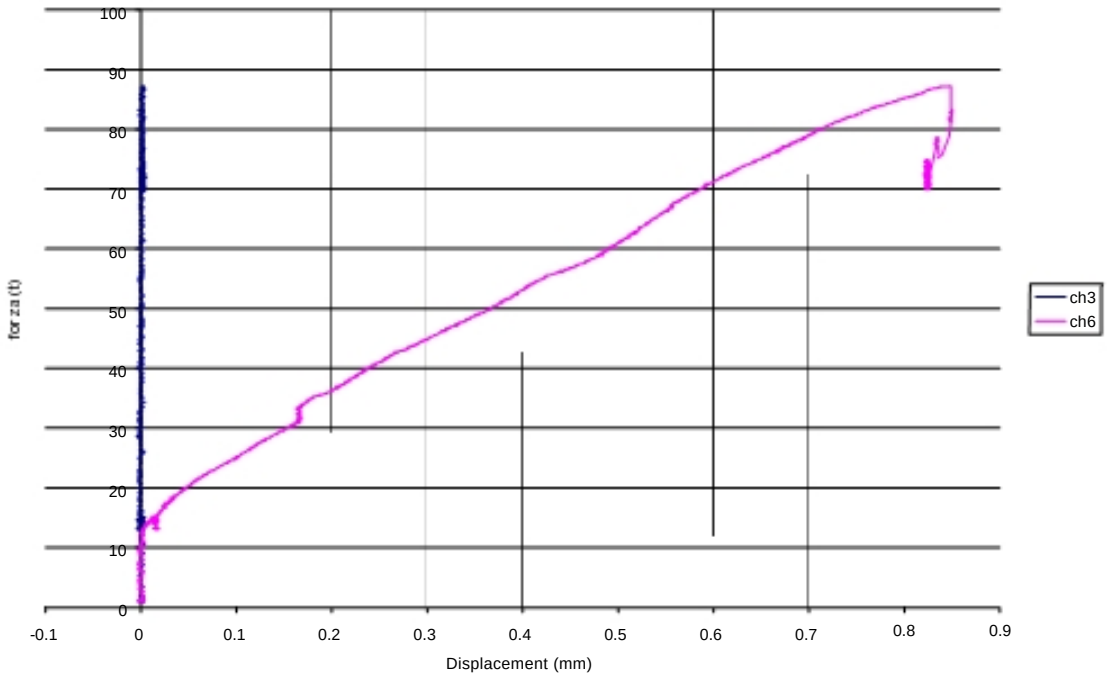
### 6.3.1 Test E1

Test performed on 27/03/08

VERTICALS



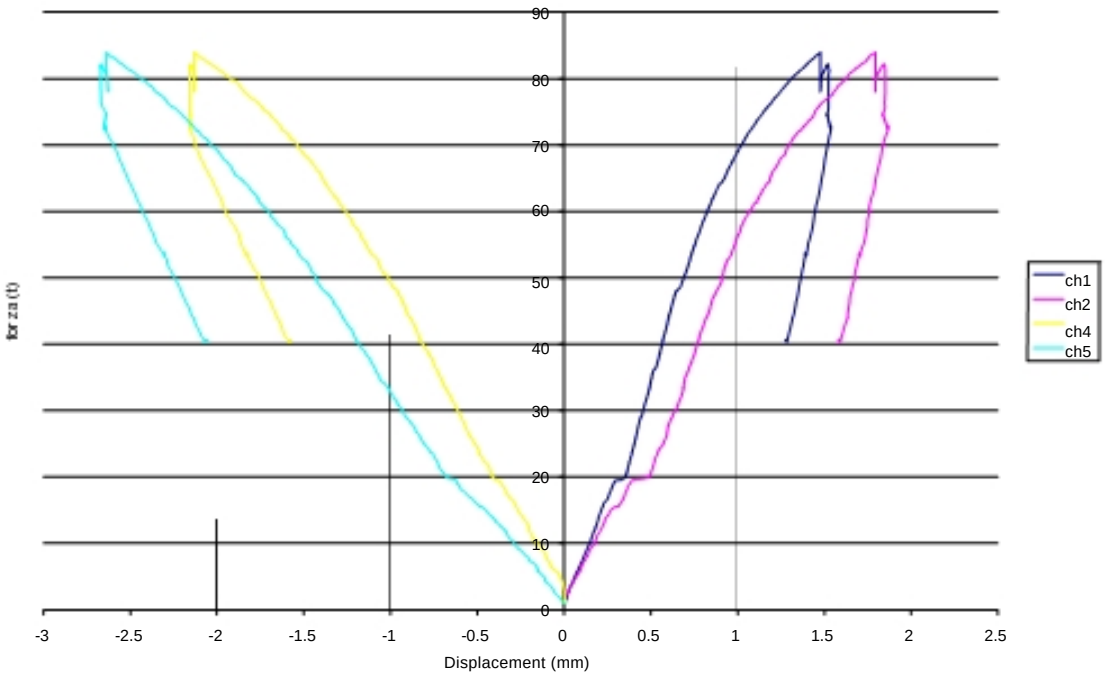

HORIZONTALS



### 6.3.2 Test E2

Test performed on 27/03/08

VERTICALS




HORIZONTALS

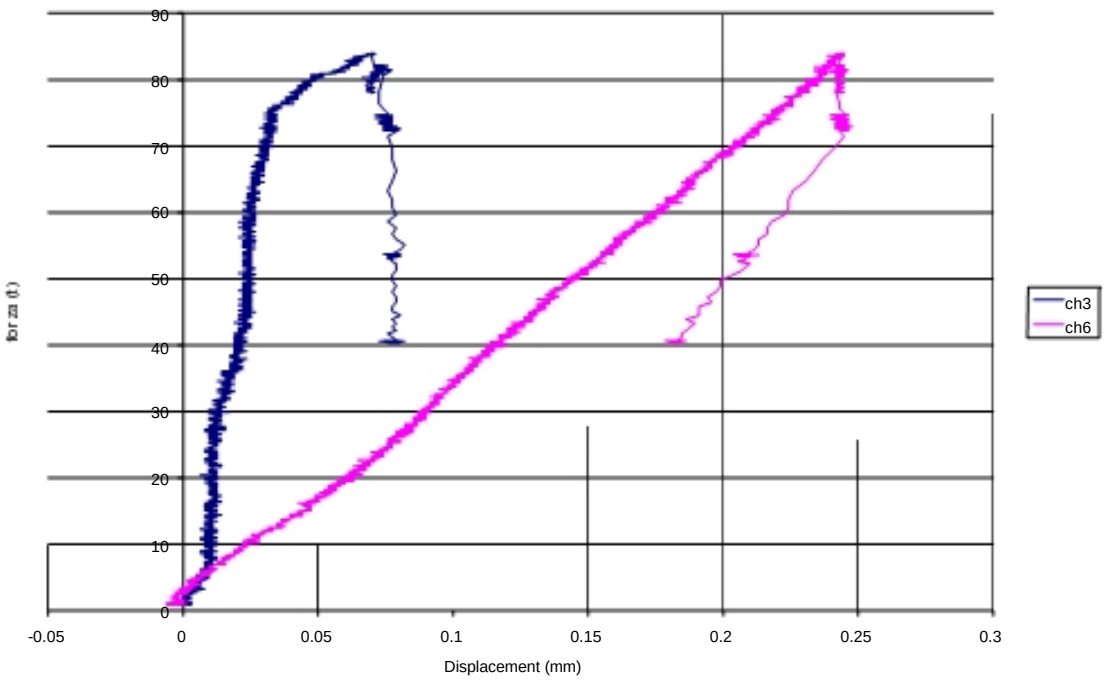


Figure 20: Application of the load


Figure 21: Fissure summary during testing

## 6.4 Delamination testing

### 6.4.1 Test De1

Test performed on 08/04/08

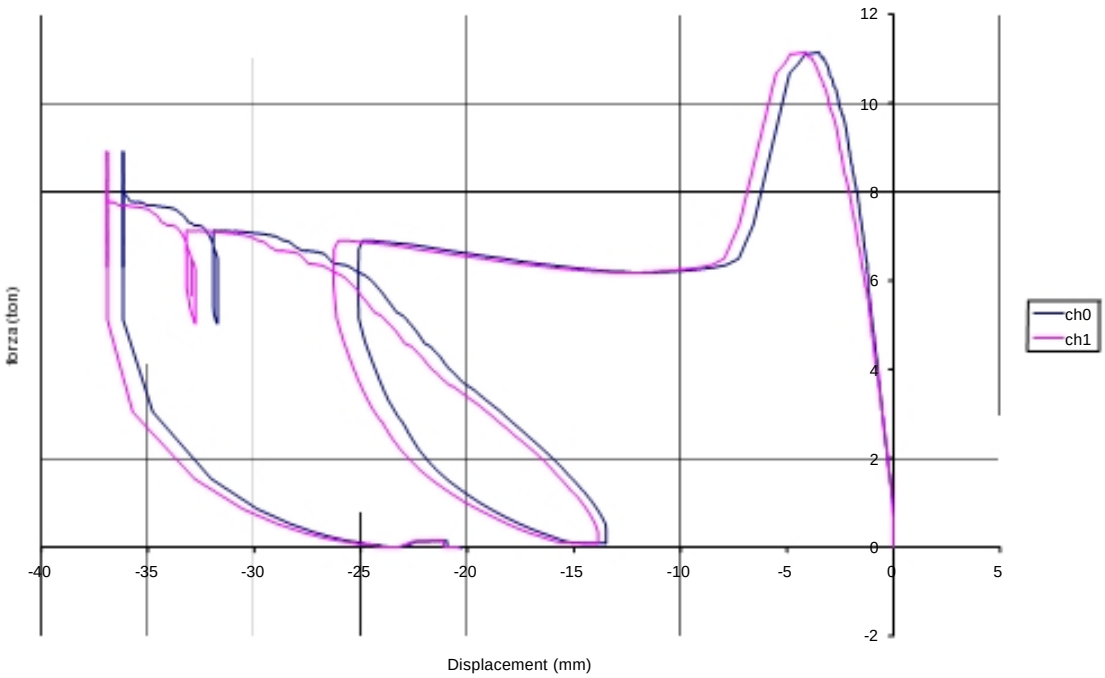
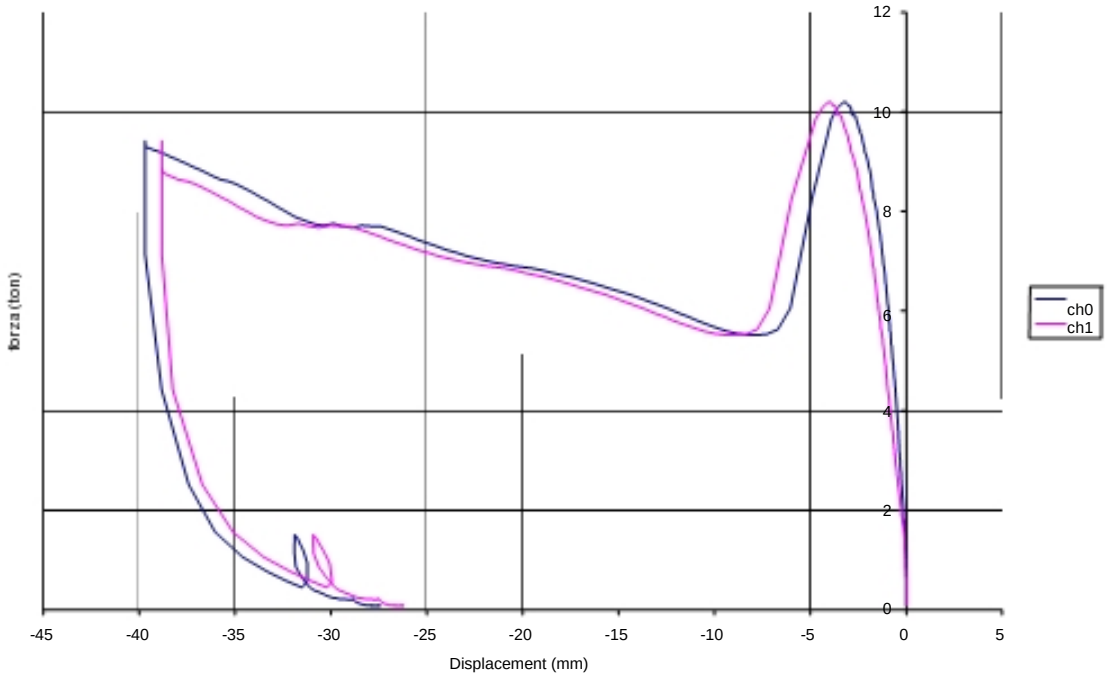




Figure 22: Sliding of the polystyrene slab

### 6.4.2 Test De1

Test performed on 08/04/08



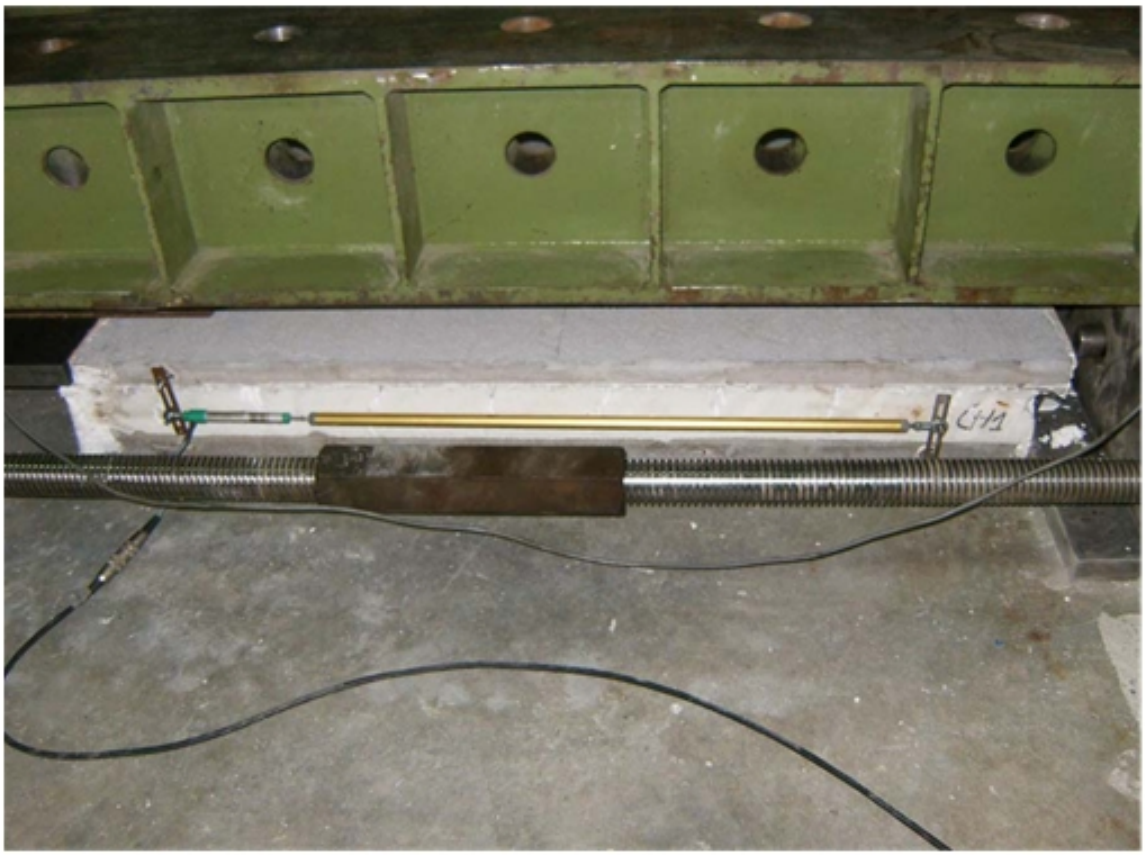




Figure 23: Sliding of the polystyrene slab

Figure 24: Diagonal fissures in the polystyrene

## 7. CD Contents

The CD contains the folders C1, C2, C3, C4, C5, C6, E1, E2, D1, D2, De1 and De2, regarding the respective tests.

Each folder contains a text file, which contains all of the data acquired during the test, as well as an Excel-format file, which contains the elaborated data and the photographs taken during test.

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Technical Testing Manager
Dr. Eng. Maria Pia Scovenna

Auditor
Dr. Eng. Davide Bolognini