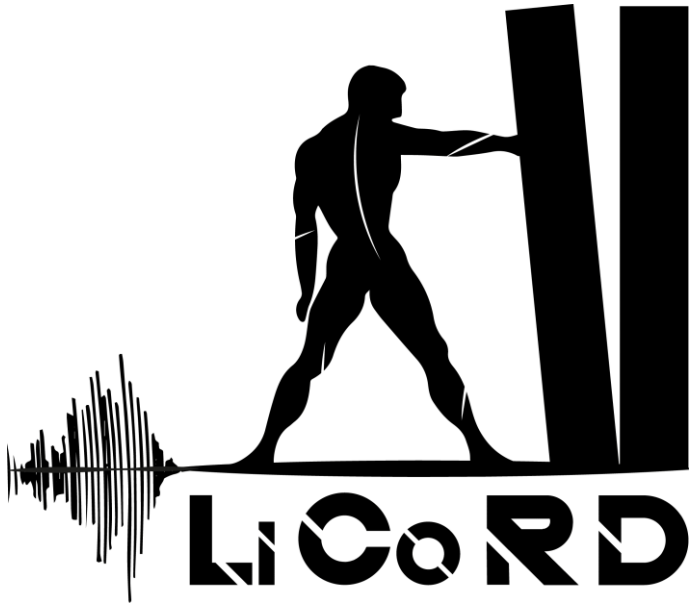


LiCoRD

solution for the seismic protection and structural monitoring

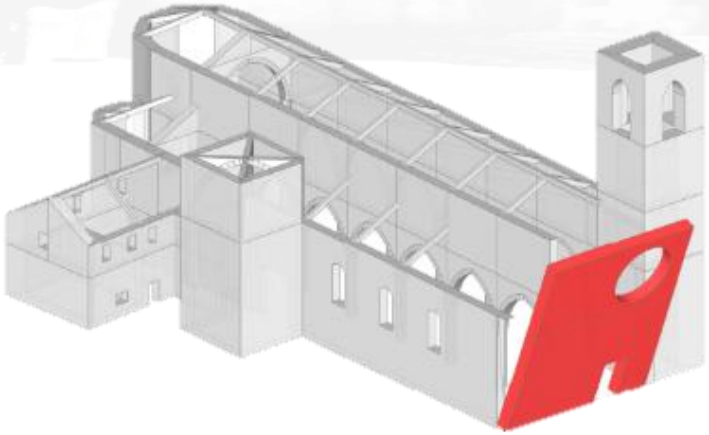
Livith®
POWER TEAM

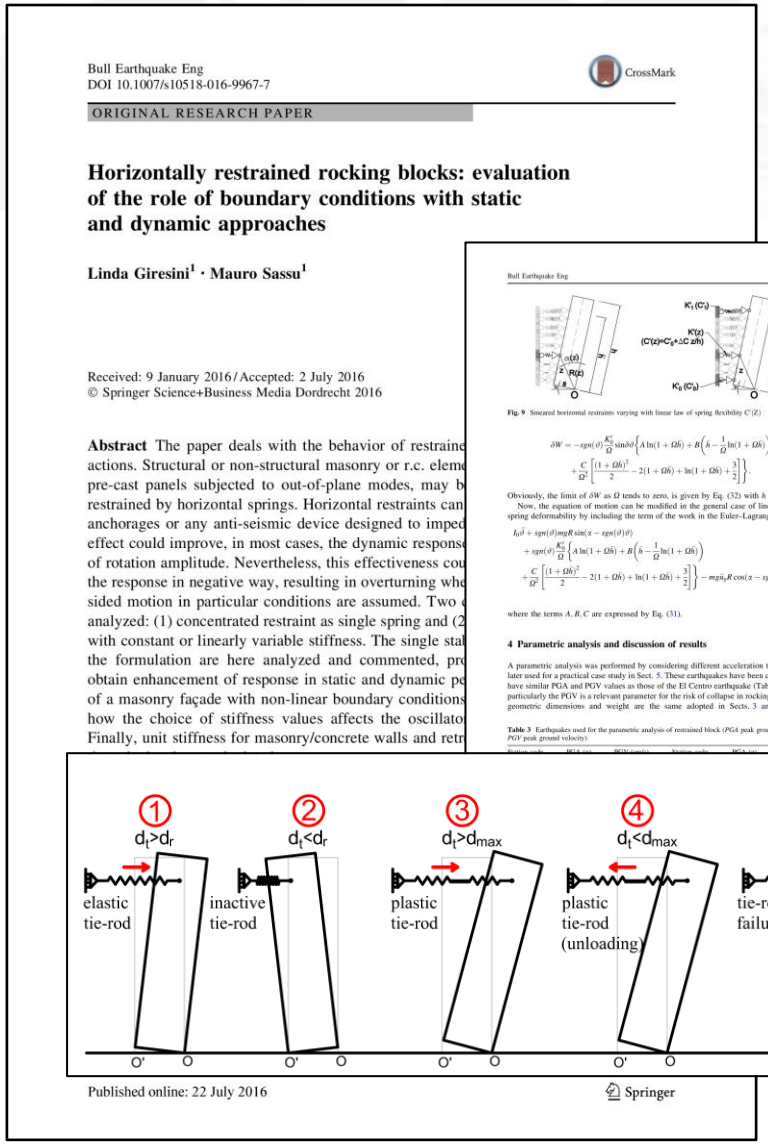
Linear Controlled Rocking Device

2017 Preliminary studies on restraint rocking blocks were performed

2018 Thanks to the strong synergy with the University of Pisa and Livith group, LiCoRD project was born

2021 From the project to the company





Bull Earthquake Eng
DOI 10.1007/s10518-016-9967-7

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ORIGINAL RESEARCH PAPER

Horizontally restrained rocking blocks: evaluation of the role of boundary conditions with static and dynamic approaches

Linda Giresini[1] · Mauro Sassu[1]

Received: 9 January 2016 / Accepted: 2 July 2016
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Abstract The paper deals with the behavior of restraine
actions. Structural or non-structural masonry or r.c. eleme
pre-cast panels subjected to out-of-plane modes, may b
restrained by horizontal springs. Horizontal restraints can
anchorages or any anti-seismic device designed to impec
effect could improve, in most cases, the dynamic respons
of rotation amplitude. Nevertheless, this effectiveness cou
the response in negative way, resulting in overturning whe
sided motion in particular conditions are assumed. Two
analyzed: (1) concentrated restraint as single spring and (2
with constant or linearly variable stiffness. The single stal
the formulation are here analyzed and commented, pr
obtain enhancement of response in static and dynamic pe
of a masonry façade with non-linear boundary conditions
how the choice of stiffness values affects the oscillato
Finally, unit stiffness for masonry/concrete walls and retr

Bull Earthquake Eng

Fig. 9 Smeared horizontal restraints varying with linear law of spring flexibility $C'(Z)$

$$\delta W = -sgn(\dot{\theta})\frac{K_0'}{\Omega}\sin\delta\dot{\theta}\left\{A\ln(1+\Omega\delta) + B\left(\delta - \frac{1}{\Omega}\ln(1+\Omega\delta)\right) + \frac{C}{\Omega^2}\left[\frac{(1+\Omega\delta)^2}{2} - 2(1+\Omega\delta) + \ln(1+\Omega\delta) + \frac{3}{2}\right]\right\} \quad (51)$$

Obviously, the limit of δW as Ω tends to zero, is given by Eq. (32) with $h = \delta$.

Now, the equation of motion can be modified in the general case of linearly variable spring deformability by including the term of the work in the Euler-Lagrange's equation:

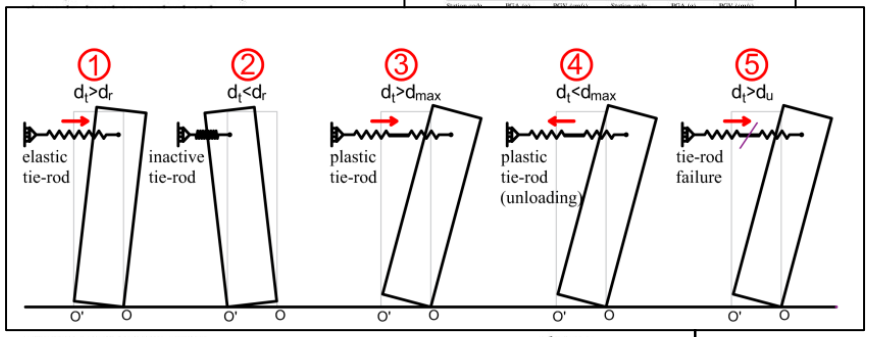
$$I_0\ddot{\theta} + sgn(\dot{\theta})mgR\sin(\alpha - sgn(\dot{\theta})\theta) + sgn(\dot{\theta})\frac{K_0'}{\Omega}\left\{A\ln(1+\Omega\delta) + B\left(\delta - \frac{1}{\Omega}\ln(1+\Omega\delta)\right) + \frac{C}{\Omega^2}\left[\frac{(1+\Omega\delta)^2}{2} - 2(1+\Omega\delta) + \ln(1+\Omega\delta) + \frac{3}{2}\right]\right\} - mg\ddot{u}_g R\cos(\alpha - sgn(\dot{\theta})\theta) = 0 \quad (52)$$

where the terms A, B, C are expressed by Eq. (31).

4 Parametric analysis and discussion of results

A parametric analysis was performed by considering different acceleration time-histories, later used for a practical case study in Sect. 5. These earthquakes have been chosen as they have similar PGA and PGV values as those of the El Centro earthquake (Table 3). Indeed, particularly the PGV is a relevant parameter for the risk of collapse in rocking motion. The geometric dimensions and weight are the same adopted in Sects. 3 and 4, namely

Table 3 Earthquakes used for the parametric analysis of restrained block (*PGA* peak ground acceleration, *PGV* peak ground velocity)



Published online: 22 July 2016

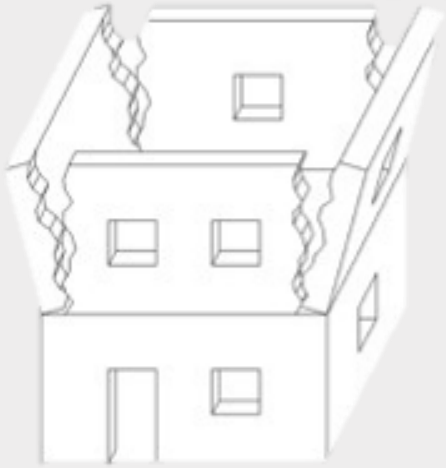
Springer

PROBLEMS & NEEDS

Licord

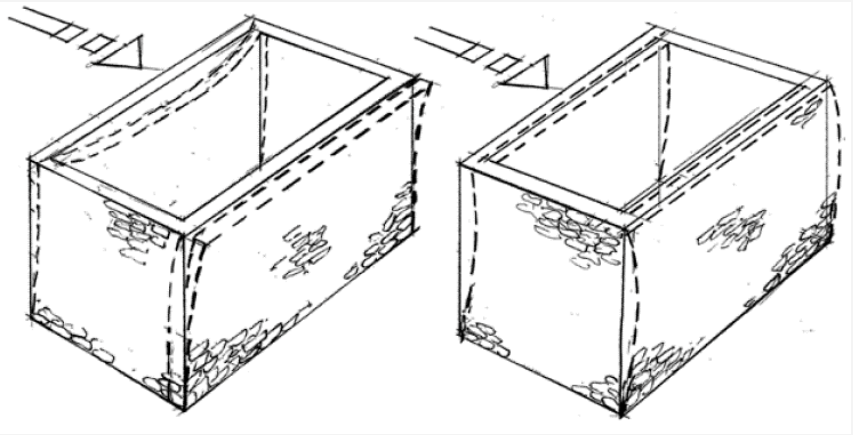
Turn problems in to solution

PROBLEMS



- High seismic vulnerability of unreinforced masonry buildings
- Out of plane of masonry portions or entire façade
- Lack of proper structural connections

NEEDS



- To promote the policy on seismic vulnerability reduction
- To guarantee and maintain the structural integrity of buildings under seismic actions
- To ensure the box behaviour avoiding local collapse mechanisms

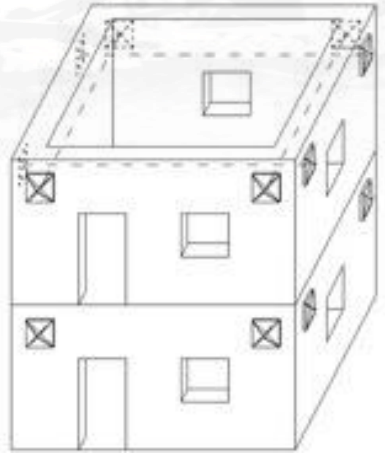
CURRENT TADITIONAL SOLUTION

Stell tie rod

Safeguard the out-of plane mechanism

STRENGTHS

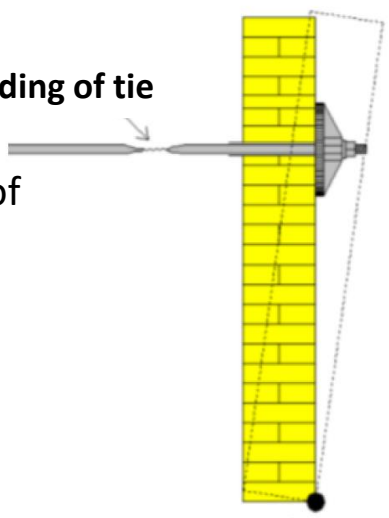
- Steel tie rods have widely been used for centuries and are still adopted nowadays to prevent the out-of-plane mechanism, enforcing the building box behavior.
- Such intervention is also suggested by current code standards and was seen to beneficially prevent the collapse of the building after medium-intensity earthquakes.



WEAKNESSES

Under highly seismic events:

- Possible damage to the masonry in the surrounding area of the tie
- Possible yielding/rupture of the ties.



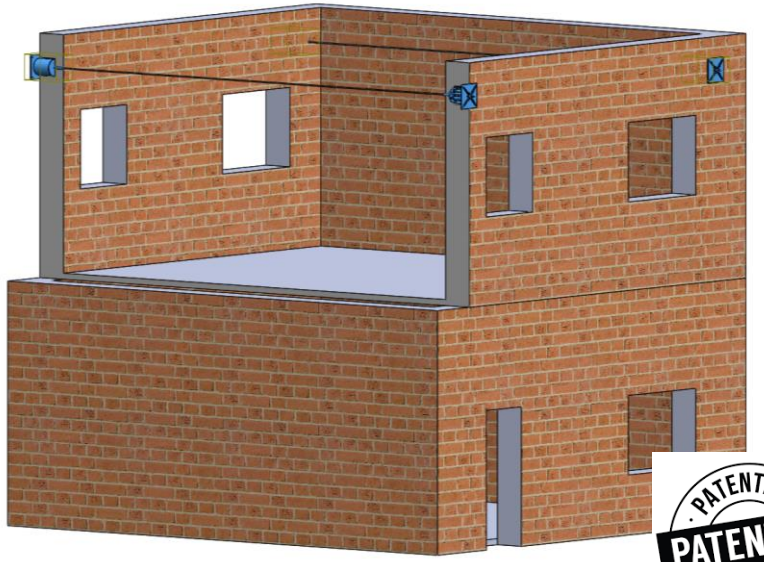
LICORD AN INNOVATIVE SOLUTION FOR THE MASONRY BUILDINGS

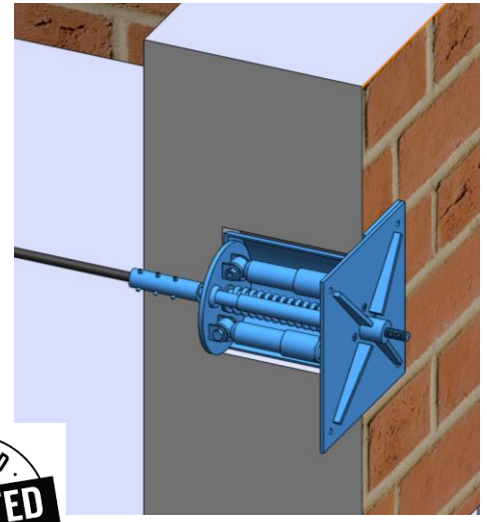
The technology

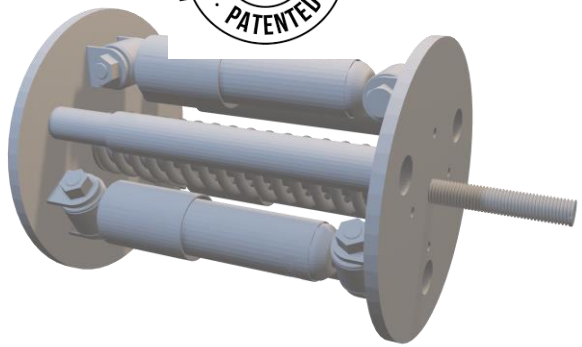
CE Certified device

- Meccanical Fuse Restraints (MFR)
- Linear Device (LD)
- Fluid Viscous Damper (FVD)

EN 15129





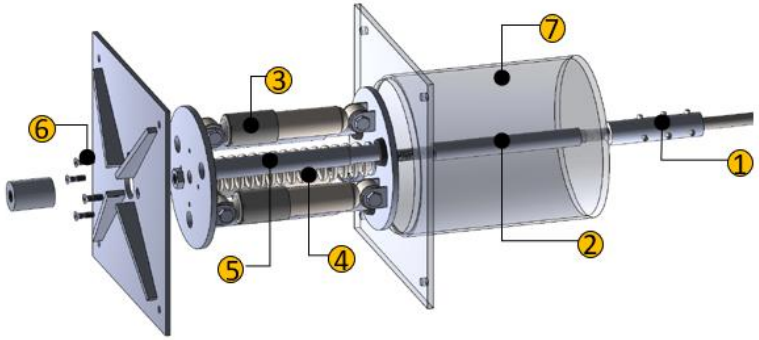


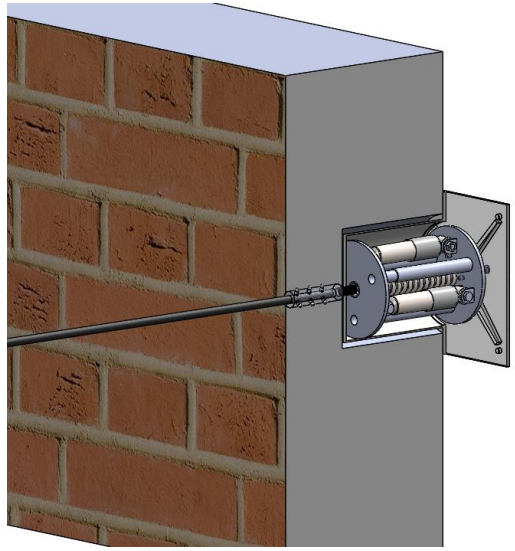
LICORD AN INNOVATIVE SOLUTION FOR THE MASONRY BUILDINGS

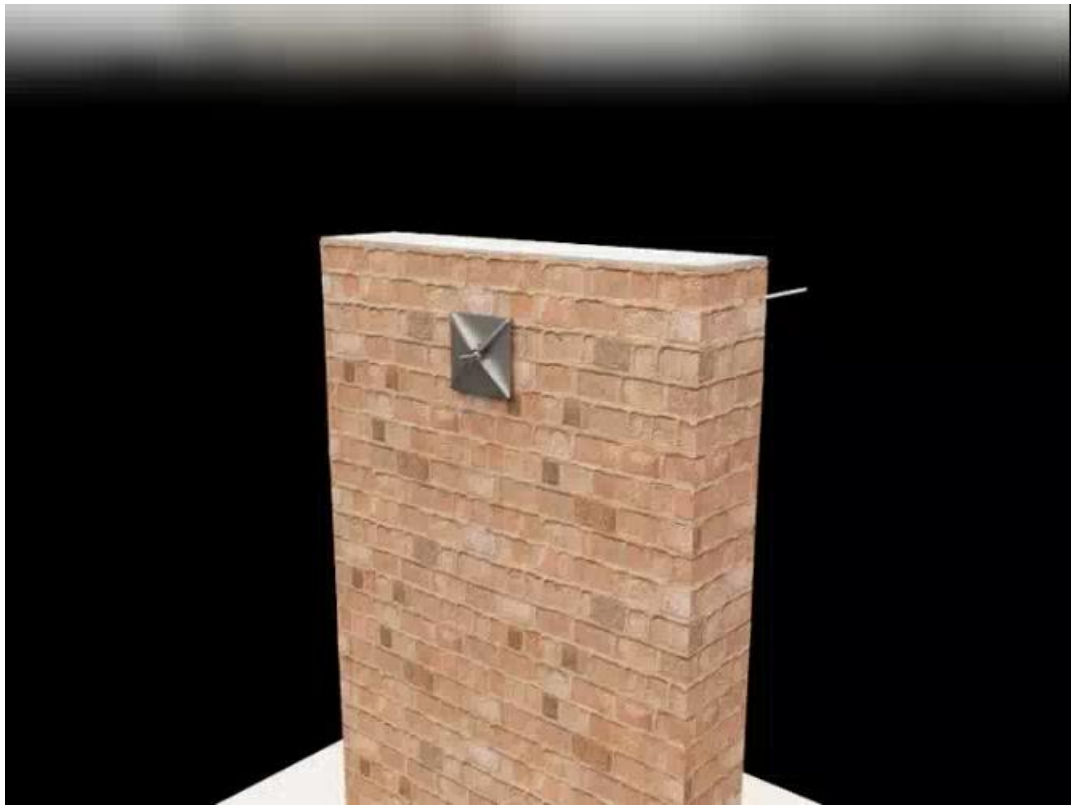
«Low installation times and low impact»

Components

1. Threaded clamp
2. Tension switch
3. Shock absorber
4. Compression spring
5. Guide tubes
6. Mechanical fuse
7. Casing
8. Closing plate







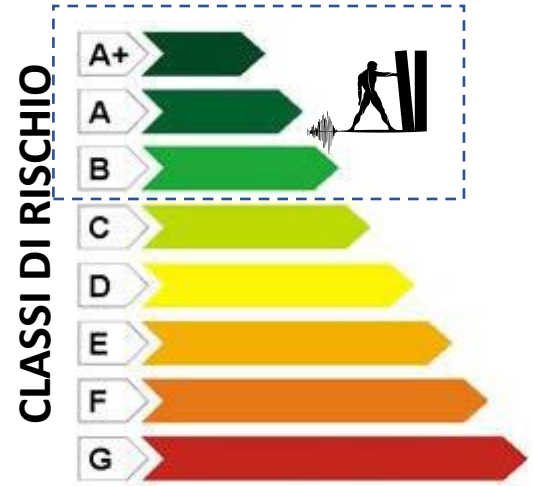
LICORD: THE INNOVATIVE SOLUTION

The first anti-seismic device patented to control the out-of-plane rocking motion of masonry walls.

«innovative, mini-invasive, and simple to be applied»

TECHNICAL ADVATAGES:

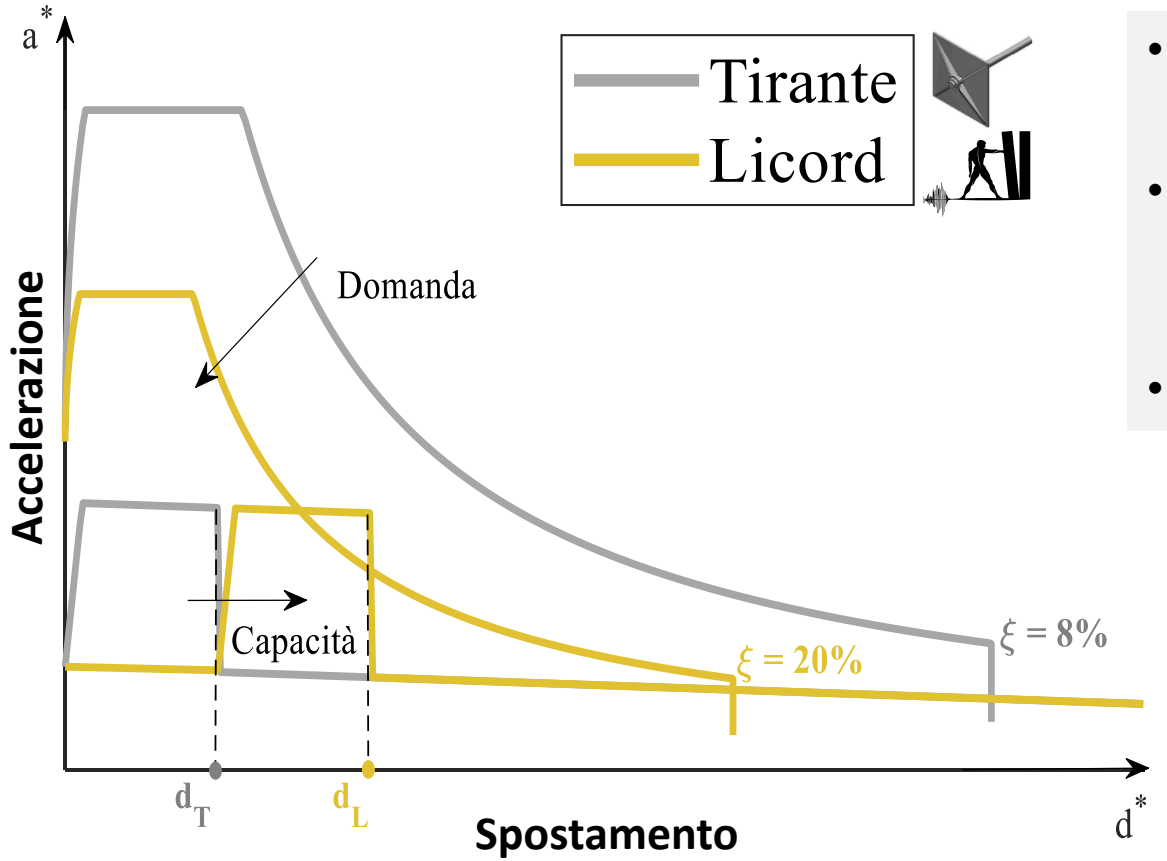
- Increasing the seismic performance of the construction
- Controlling the out of plane mechanisms of masonry buildings
- Increasing the seismic safety index up to 70% for existing buildings
- Increasing the seismic risk class
- To operate maintaining the functioning of the activities
- Monitoring the building health state and controlling the structural integrity of the system



LICORD: THE INNOVATIVE SOLUTION

The first anti-seismic device patented to control the out-of-plane rocking motion of masonry walls.

TECHNICAL ADVATAGES:



- Control the force acting on the tie
- Increase of the displacement capacity
- Reduce of the seismic demande

LICORD: THE INNOVATIVE SOLUTION

«effective investment against direct and indirect loss»

The first anti-seismic device patented to control the out-of-plane rocking motion of masonry walls.

ECONOMIC AND SOCIAL ADVANTAGES

- Safeguard human lives ensuring the functioning of productive activities
- Low installation and maintenance costs
- To reduce repairing costs
- To add value to the construction
- To safeguard the historical and cultural heritage

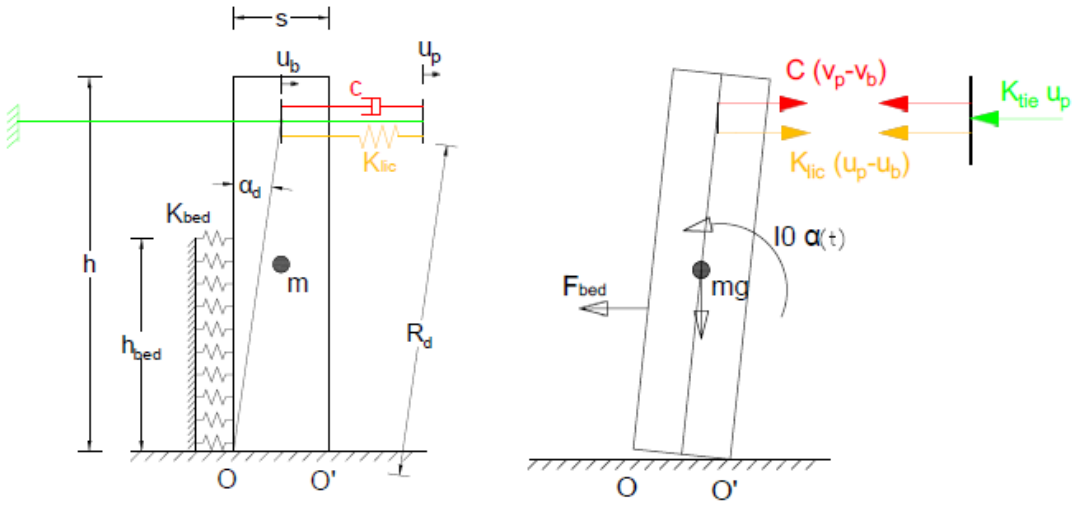
11 SUSTAINABLE CITIES AND COMMUNITIES

ICOMOS
international council on monuments and sites
CONSERVATION & SUSTAINABILITY

LICORD R&D

From the idea to the product

- **The equation of motion**
- Field experiments
- EN15129 certification
- Support to the client in all project phases



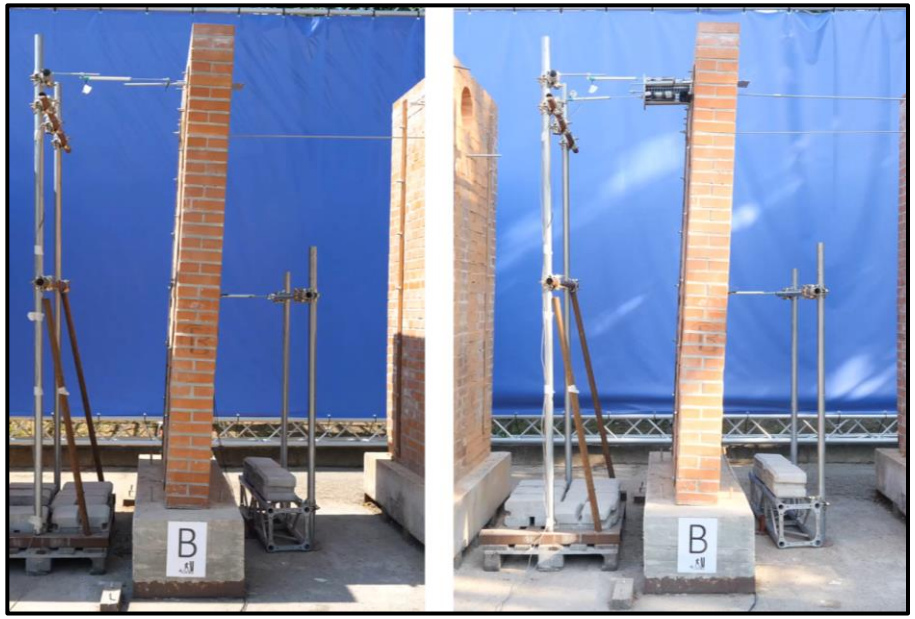
$$\begin{cases} I_0\ddot{\theta} + sign(\theta)\, m\, g\, R\, \sin A_\theta + M_{K_{bed}} - M_{K_{LIC}} - M_D = 0 \\ T_{K_{LIC}} + T_D + T_{tie} = 0 \end{cases}$$

$$\begin{aligned} M_{K_{LIC}} &= R_d \cos A_d K_{LIC} (u_p - u_b) \\ M_D &= R_d \cos A_d C (\dot{u}_p - \dot{u}_b)^\alpha \\ T_{K_{LIC}} &= K_{LIC} (u_p - u_b) \\ T_{tie} &= K_{tie}\, u_p \\ T_D &= C (\dot{u}_p - \dot{u}_b)^\alpha \end{aligned}$$

LICORD R&D

From the idea to the product

- The equation of motion
- **Field experiments**
- EN15129 certification
- Support to the client in all project phases



LICORD R&D

From the idea to the product

- The equation of motion
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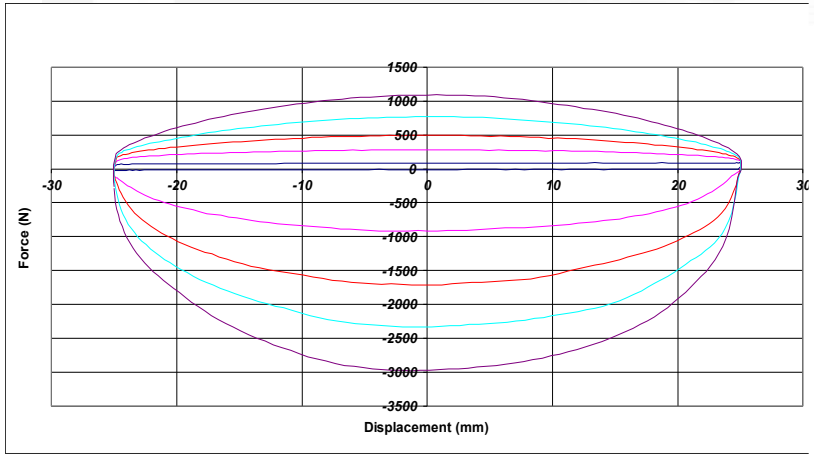
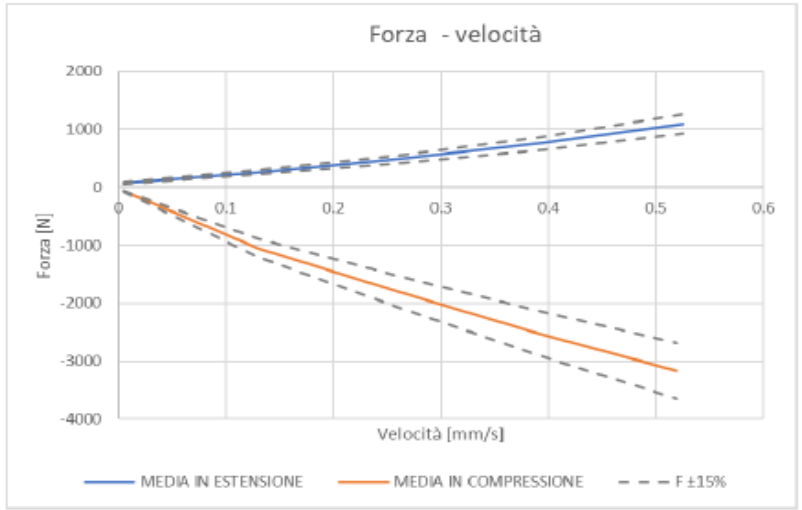
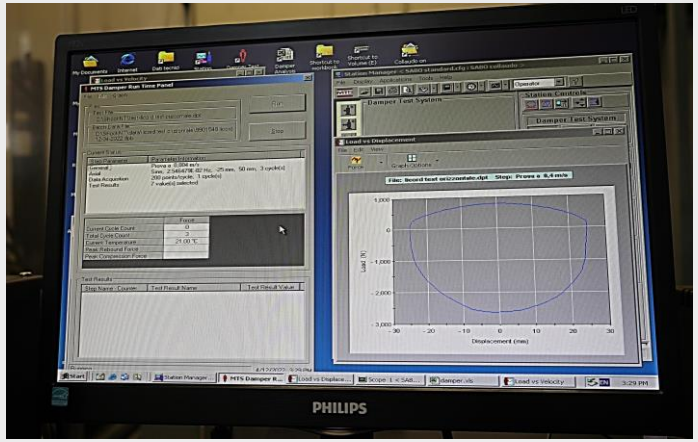
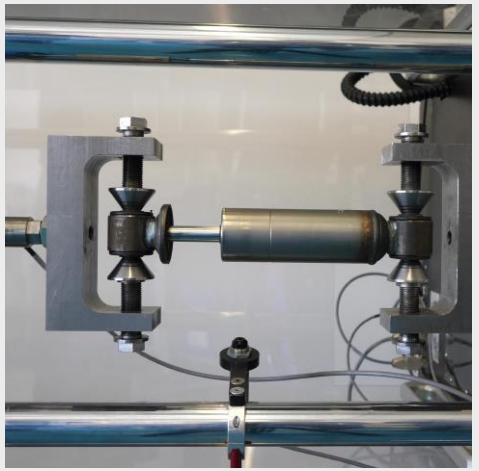






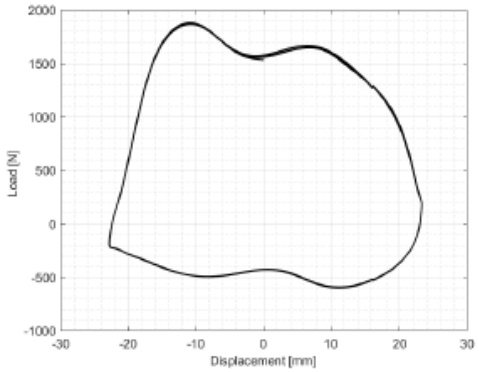


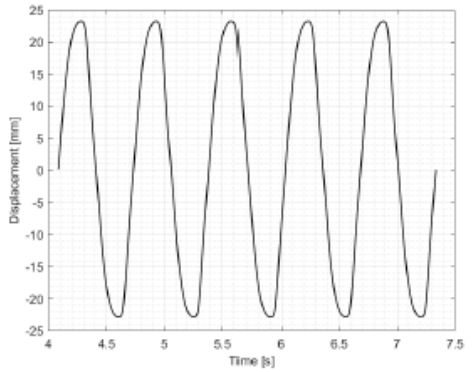
LICORD R&D

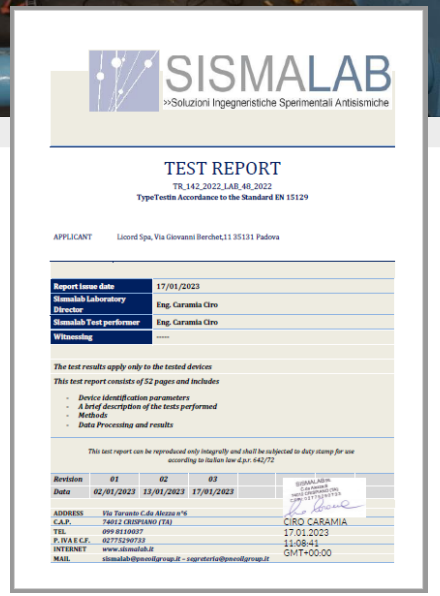
From the idea to the product

- The equation of motion
- Field experiments
- **EN15129 certification**
- Support to the client in all project phases

TEST ID 15– DAMPING EFFICIENCY– 50% MAXIMUM VELOCITY







SISMALAB
>>Soluzioni Ingegneristiche Sperimentali Antisismiche

TEST REPORT

TR_142_2022_LAB_48_2022

TypeTestin Accordance to the Standard EN 15129

APPLICANT Licord Spa, Via Giovanni Berchet,11 35131 Padova

Report issue date	17/01/2023
Sismalab Laboratory Director	Eng. Caramia Ciro
Sismalab Test performer	Eng. Caramia Ciro
Witnessing	-----

The test results apply only to the tested devices

This test report consists of 52 pages and includes

- *Device identification parameters*
- *A brief description of the tests performed*
- *Methods*
- *Data Processing and results*

This test report can be reproduced only integrally and shall be subjected to duty stamp for use according to italian law d.p.r. 642/72

Revision	01	02	03
Data	02/01/2023	13/01/2023	17/01/2023

ADDRESS	Via Taranto Cda Alezza n°6
C.A.P.	74012 CRISPIANO (TA)
TEL	099 8110037
P. IVA E C.F.	02775290733
INTERNET	www.sismalab.it
MAIL	sismalab@pmeolgroup.it - segreteria@pmeolgroup.it

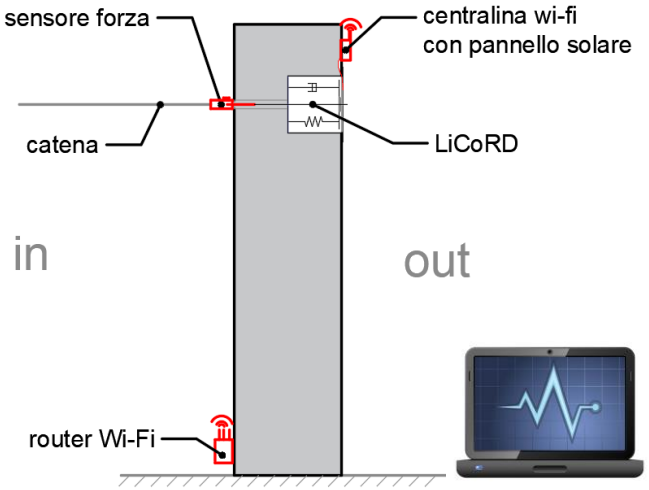
CIRO CARAMIA
17.01.2023
11:08:41
GMT+00:00

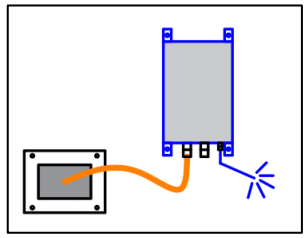
The monitoring system

1. Axial force on the tie
2. Specific online platform with cloud storage
3. Easy elaboration and export data
4. Alert system

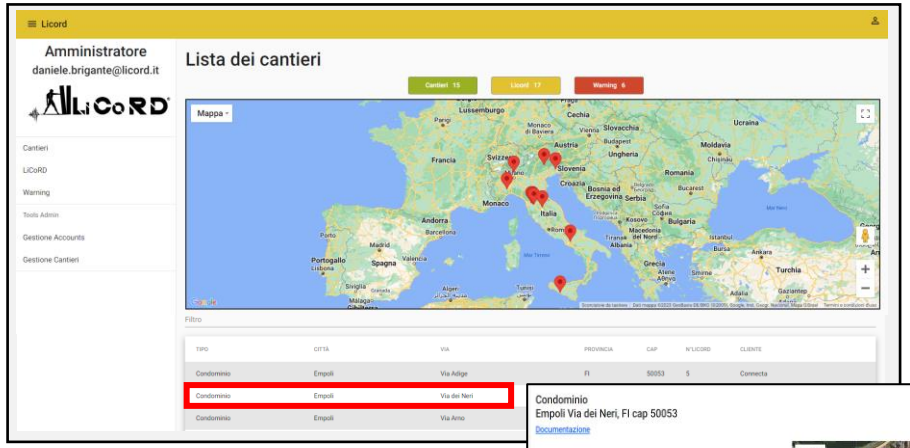
THE MONITORING SYSTEM

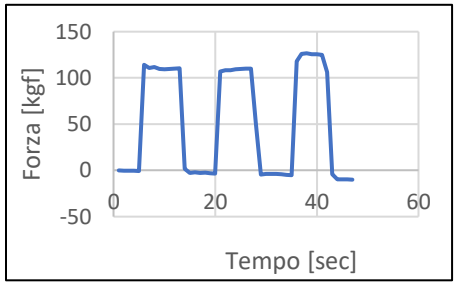
THE SYSTEM

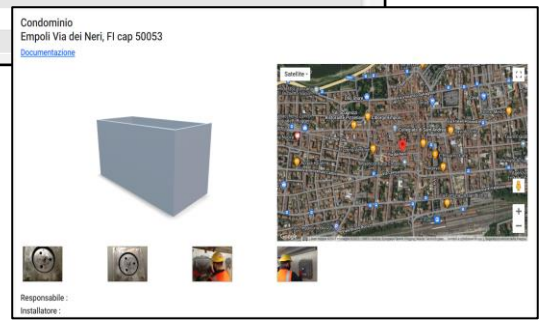




THE PLATFORM





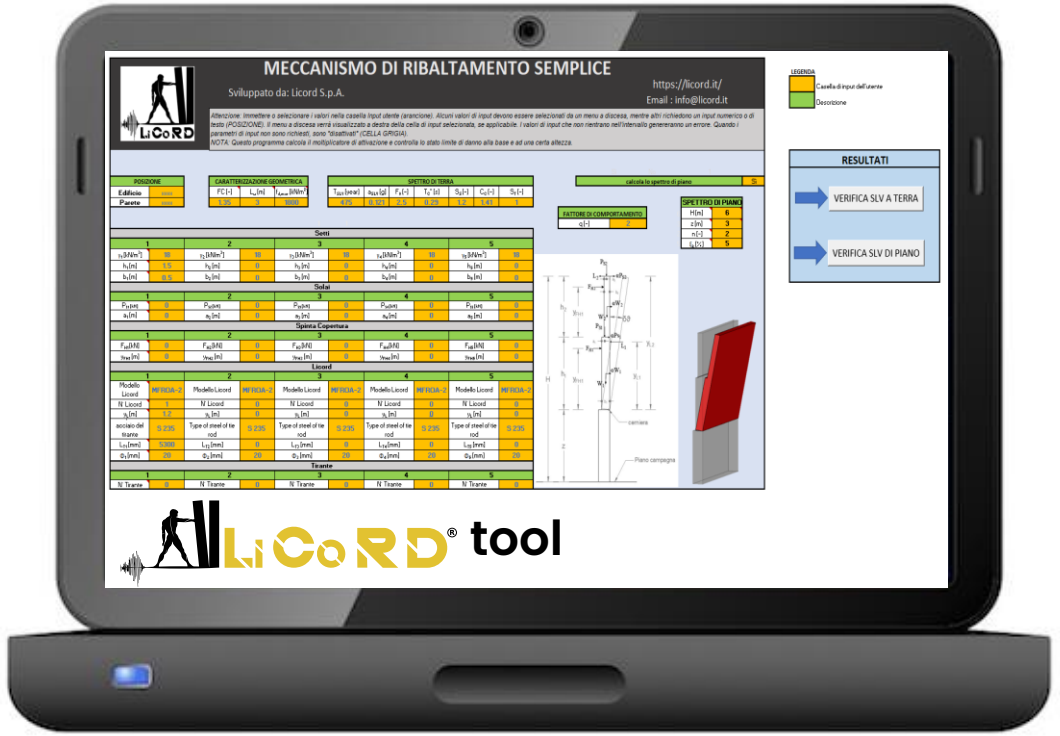


LICORD SOFTWARE

User friendly tool

- Local mechanisms
- Linear static analysis
- Non linear static analysis
- Assesment
- Technical Report

«Free software for designer»



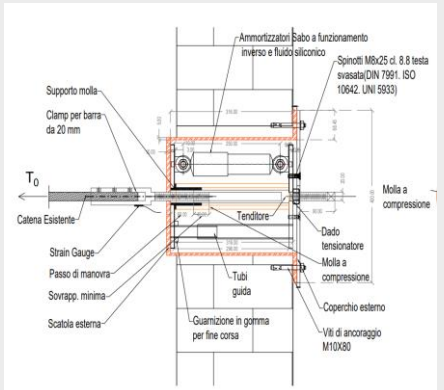
LICORD: FROM THE PROJECT TO THE INSTALLATION

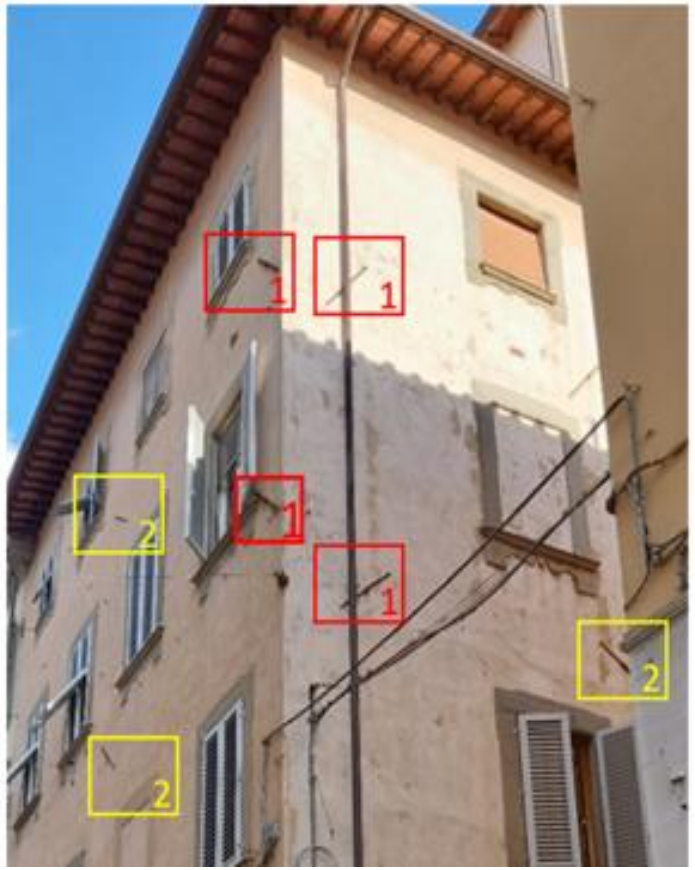
Services and technical solutions

- **Technical assistance**
- Installation and maintenance
- Monitoring plan
- Custumer service

Case study: **Palazzo Via dei Neri – Empoli**

Installation on **15** existing tie rods





Services and technical solutions

- Technical assistance
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LICORD: FROM THE PROJECT TO THE INSTALLATION

Case study: **Palazzo Via dei Neri – Empoli**

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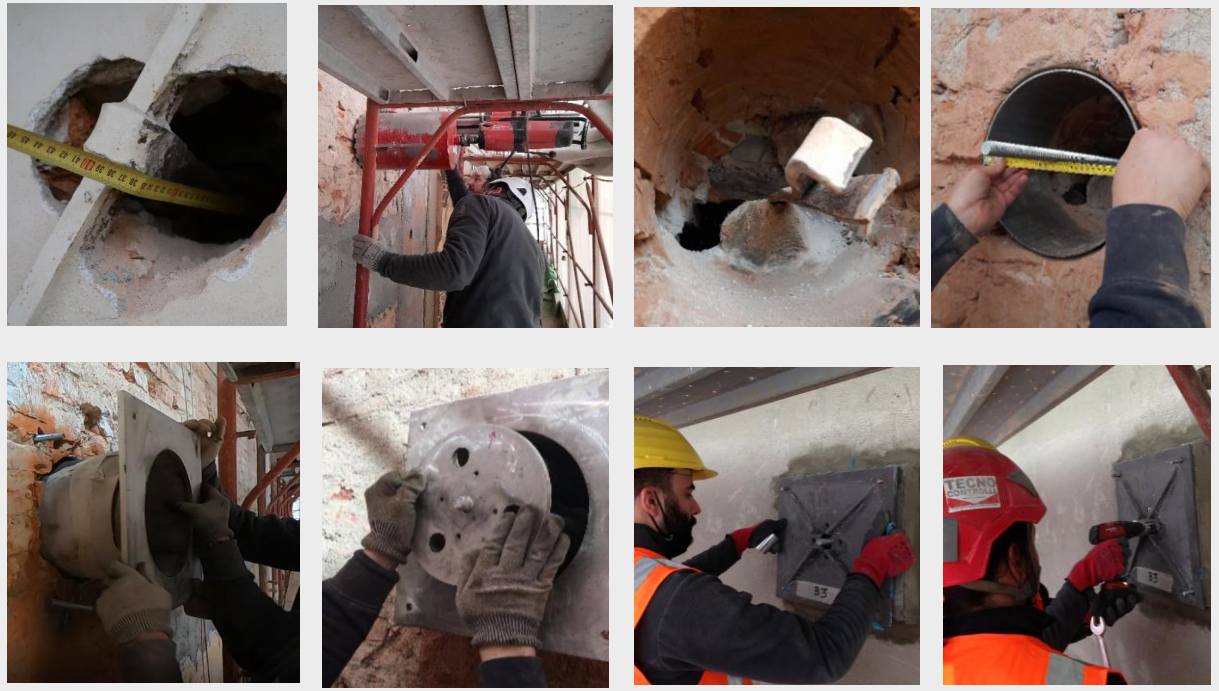
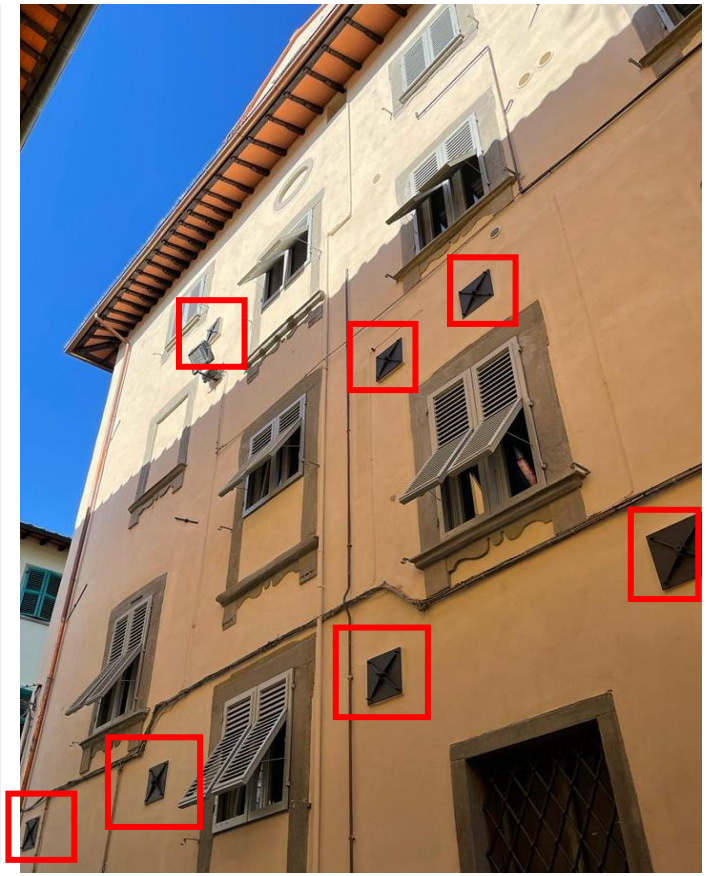
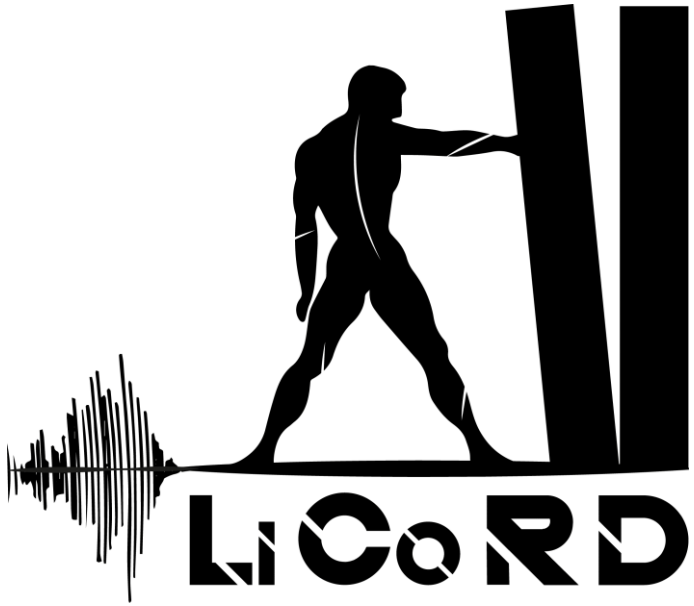


Qualified installers



AWARDS

- Step 1 EIC Accelerator 2021
- Premio Innovazione Toscana 2021
- Premio America Innovazione 2023



Registred office:

Via Giovanni Berchet, 11

35131 Padova (PD) - ITALY

Operating office:

Via Adige, 2

50025 Montespertoli (FI) - ITALY

Tel.: +39 0571 1730829

www.licord.it

info@licord.it

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