



Heritage Problems. Causes. Solutions



Erasmus+

Heritage Problems. Causes. Solutions

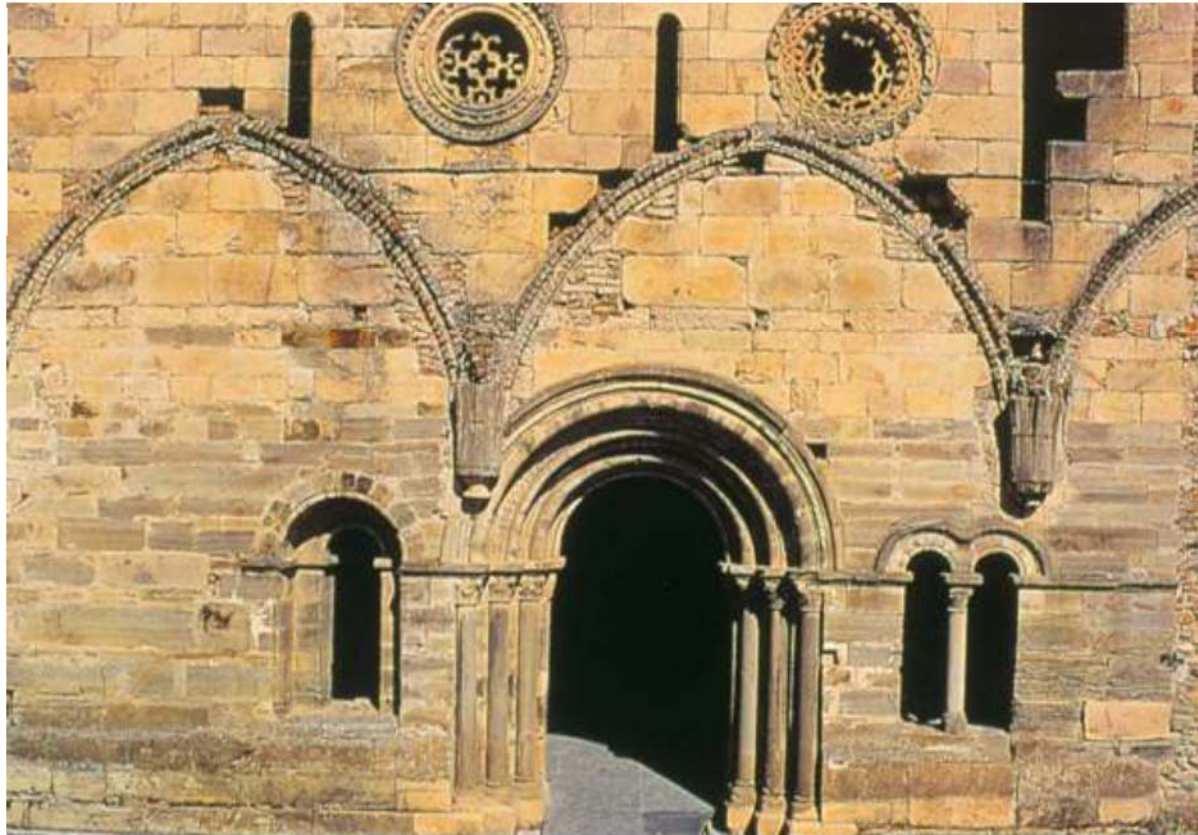
3 ECTS

SH

Sustainable Heritage

EC

Elective Courses



1. INTRODUCTION
2. FOUNDATIONS: DAMAGES
3. FOUNDATIONS: REPAIR SOLUTIONS
4. WALLS: CONSTRUCTIVE SYSTEM
- 5. WALLS II: PROBLEMS AND CAUSES**
6. WALLS III: SOLUTIONS
7. VAULTS: CONSTRUCTIVE SYSTEM
8. VAULTS II: PROBLEMS AND CAUSES
9. VAULTS III: SOLUTIONS
10. FLOORS
11. WOOD
12. ROOFS: CONSTRUCTIVE SYSTEM, PROBLEMS
AND CAUSES
13. ROOFS II: SOLUTIONS
14. OTHER TRADITIONAL STRUCTURES
15. SURFACE FINISHES, INTERIOR WOODWORK

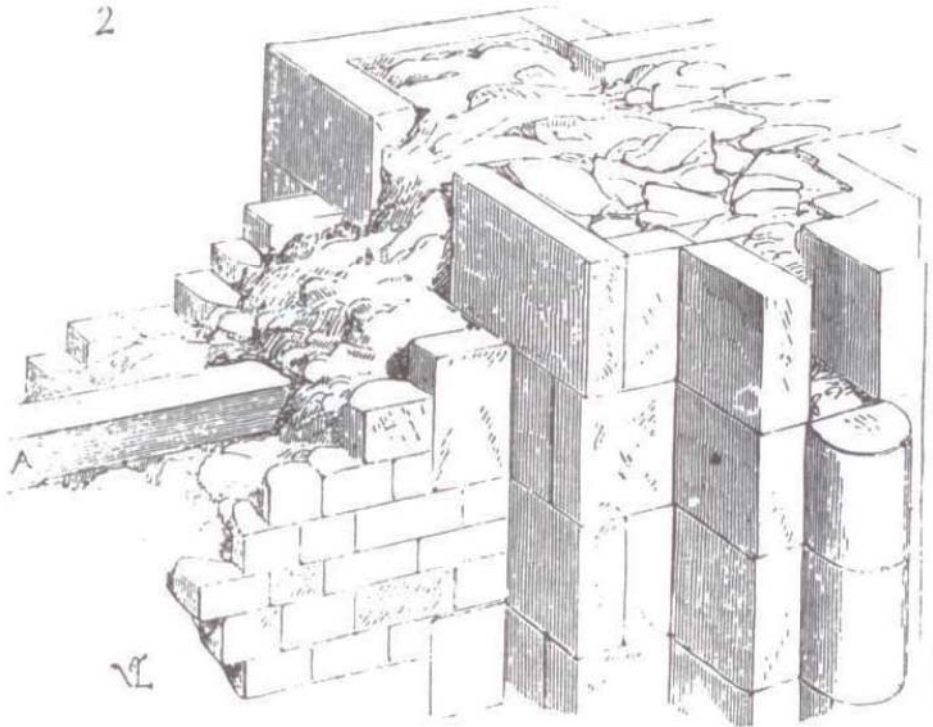
CURRICULAR CONTENTS

HERITAGE PROBLEMS. CAUSES. SOLUTIONS

Heritage Problems. Causes. Solutions

3 ECTS

2



05 WALLS II: PROBLEMS AND CAUSES

- 1. DAMAGES AND BACKGROUND**
- 2. ANALYSIS OF OBSERVED PATHOLOGY**
- 3. VERIFICATION OF THE HYPOTHESES**
- 4. SELECTION OF REPAIR SOLUTIONS**
- 5. EXECUTION OF THE WORKS**

05 WALLS II

METHODOLOGICAL APPROACH

1. DAMAGES AND BACKGROUND

- ORIGINAL PROJECT
- HISTORICAL REFERENCES:
 - PHOTOGRAPHS, DOCUMENTS, TESTIMONIES
- EXISTENCE OF PREVIOUS BUILDINGS
- STRUCTURAL OR ARCHITECTURAL MODIFICATIONS
- DAMAGES: EARTHQUAKES, FLOODING...
- MODIFICATIONS OF THE ENVIRONMENT:
 - EXCAVATIONS, PAVING, SANITATION, WELLS, CELLARS...

05 WALLS II

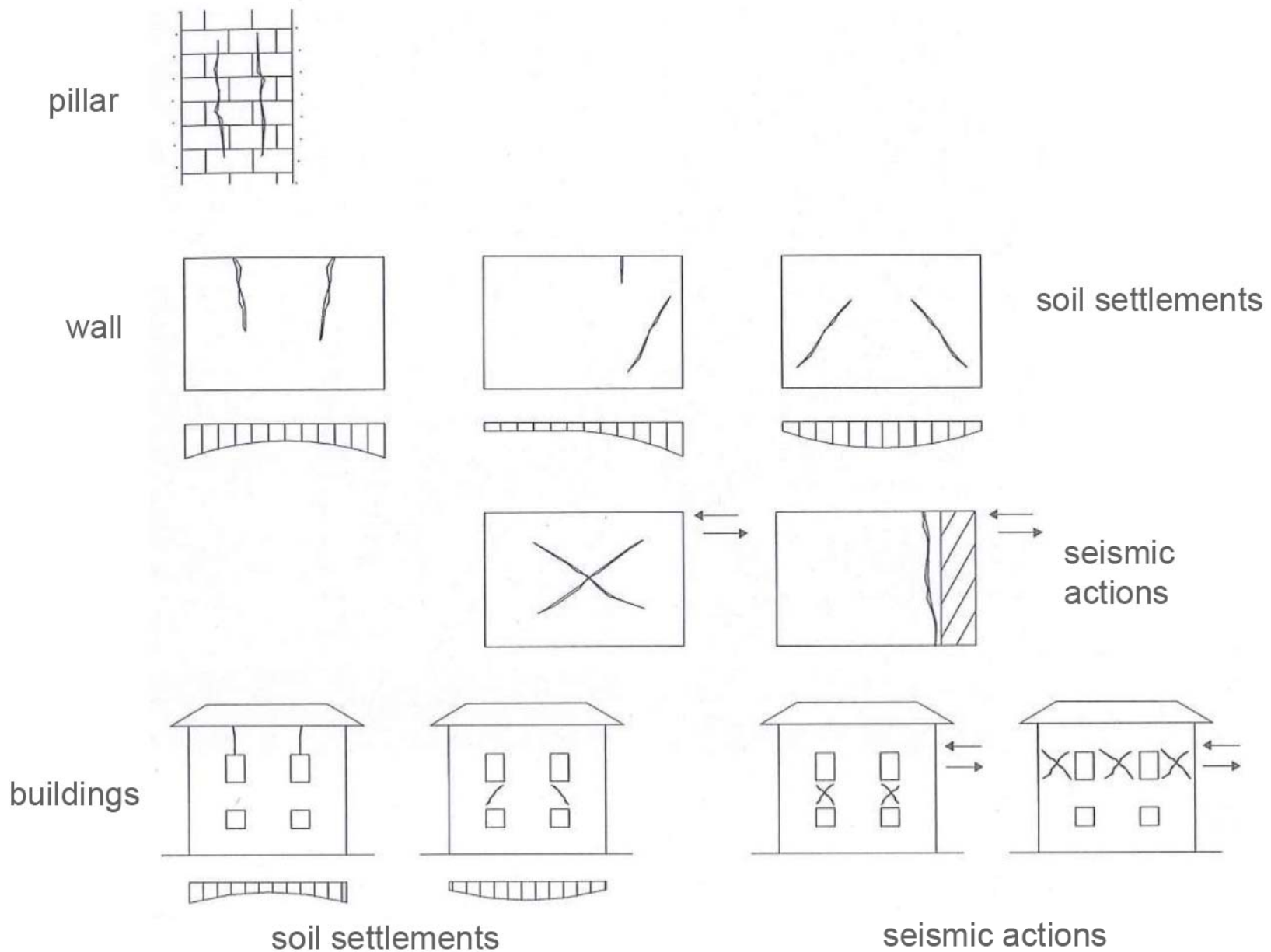
METHODOLOGICAL APPROACH

2. ANALYSIS OF OBSERVED PATHOLOGY

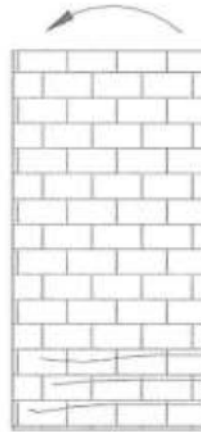
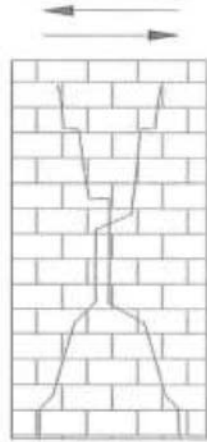
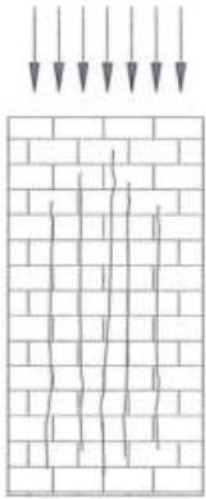
- VERIFY THE ORIGIN OF DAMAGES
- TYPOLOGY OF WALL PROBLEMS:
 - FISSURES
 - CRACKS
 - DEFORMATION
 - INCLINATION
 - DETERIORATION
 - LOSS OF MATERIAL
 - PATINA, COLOR CHANGE, VEGETATION, SALTS, EFFLORESCENCES

05 WALLS II

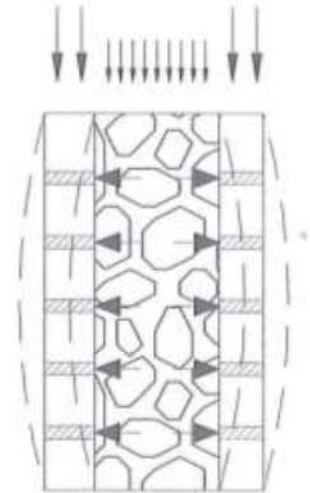
METHODOLOGICAL APPROACH



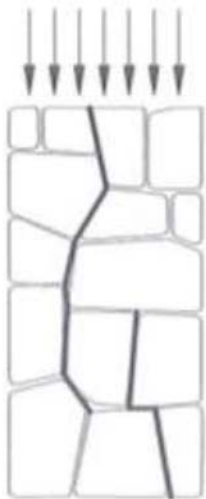
DAMAGES AND DEFORMATIONS IN A WALL STRUCTURE



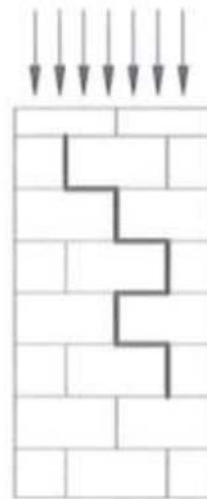
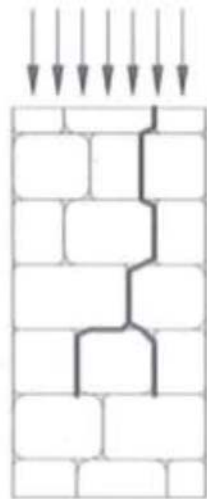
brick pillars



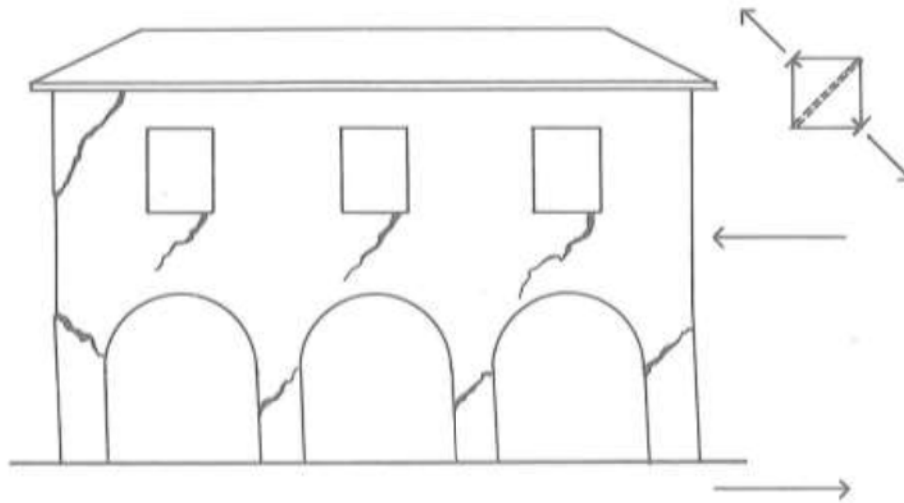
masonry pillars



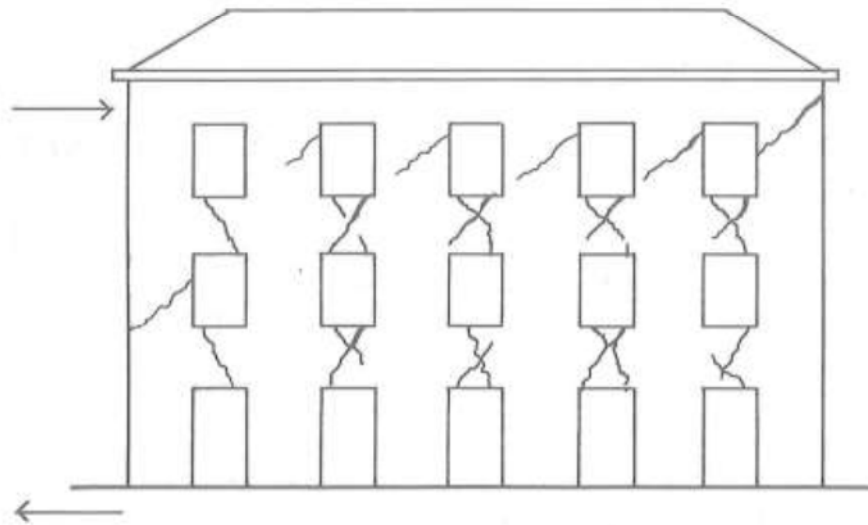
stone pillars



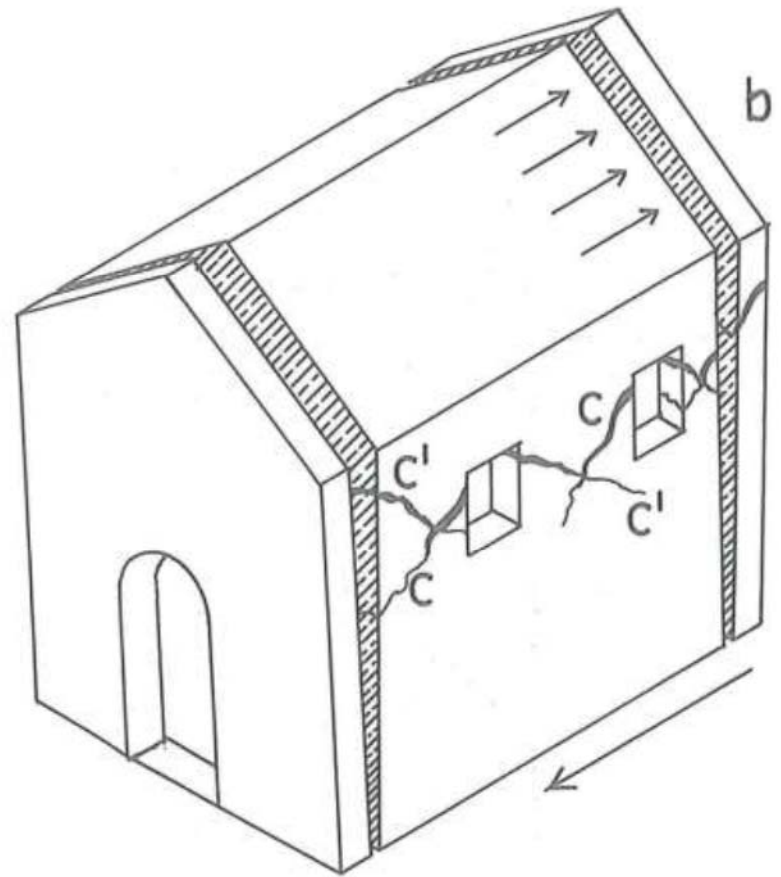
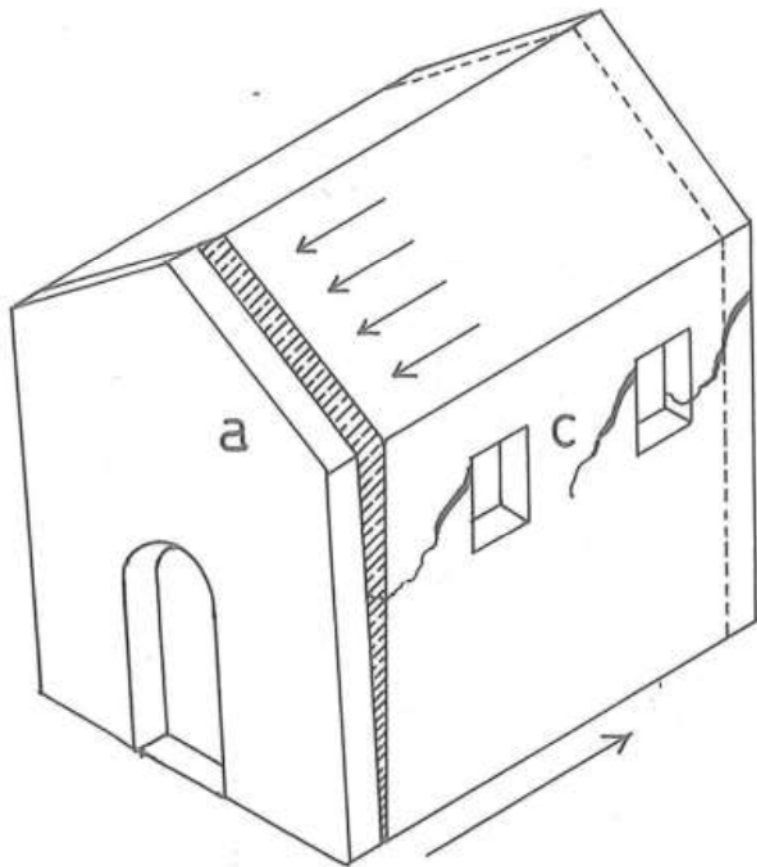
**POSSIBLE CRACKS IN MASONRY PILLARS
SUBJECT TO CRUSHING PHENOMENA**



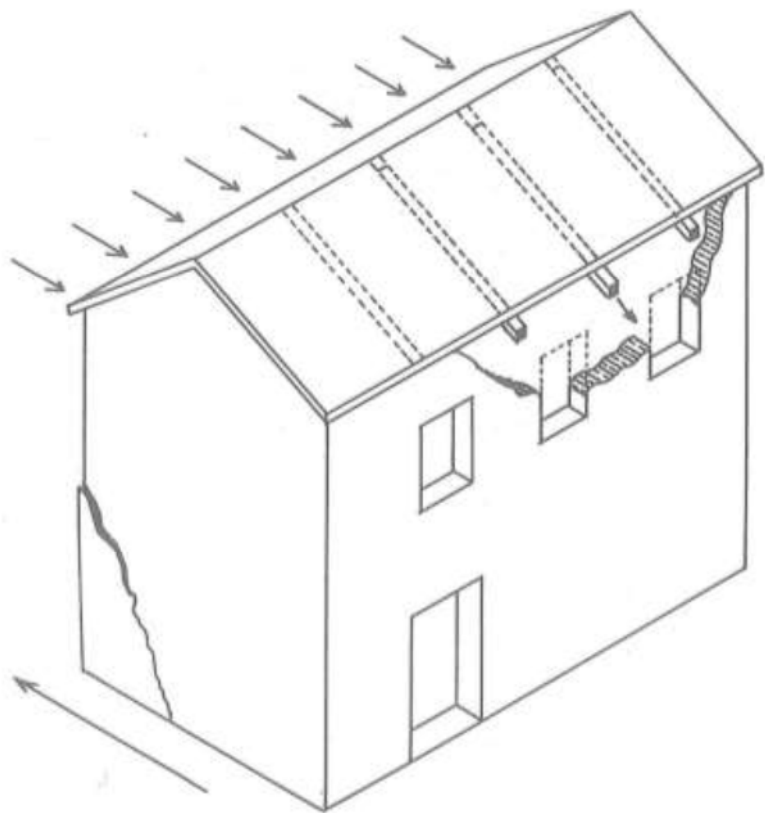
Damage in a building with a portico on the ground floor.



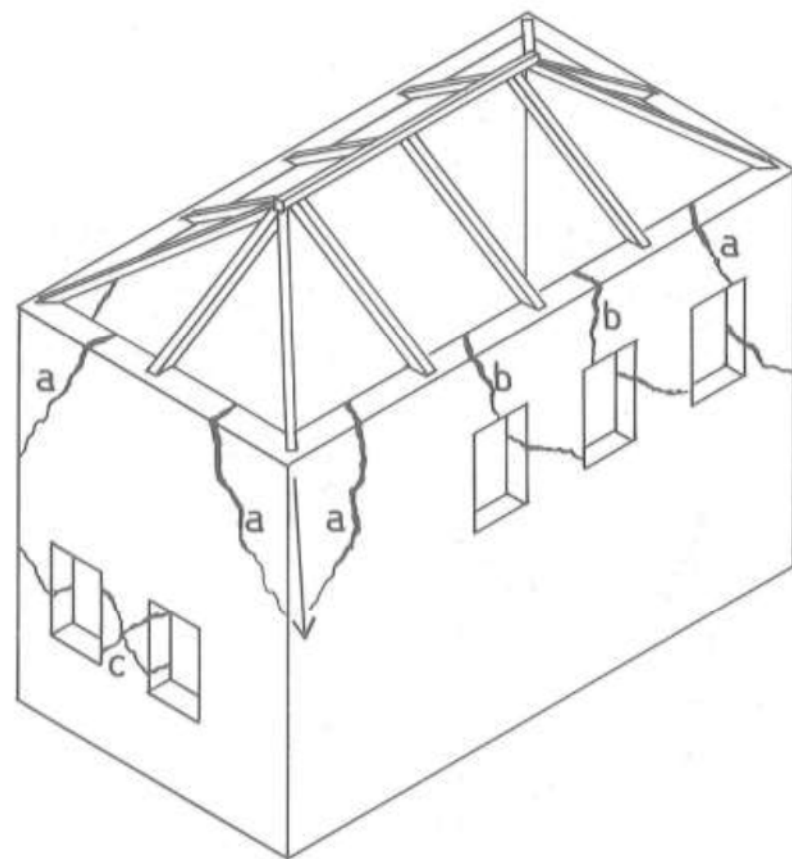
Characteristic fractures cross-shaped caused by cutting efforts in parapet-lintel areas in a facade wall subjected to parallel shockwaves



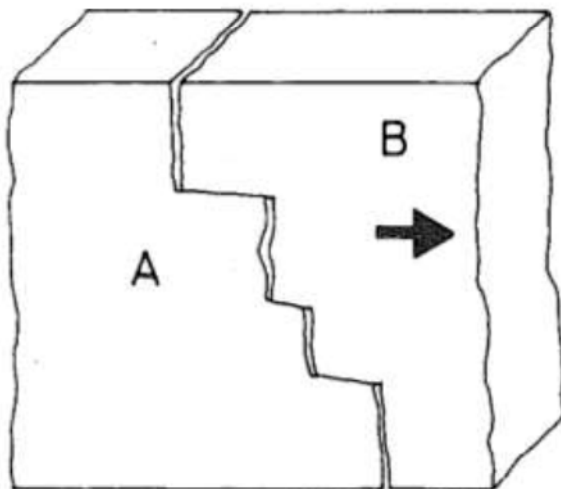
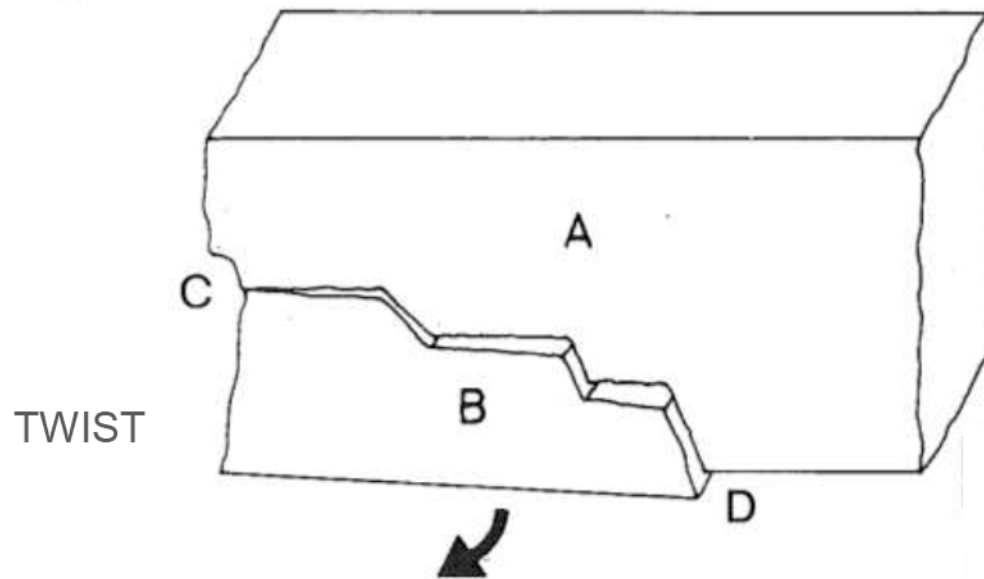
Thrust in one direction: detachment of the facade **a** and formation of fractures **c**.
 Thrust in the opposite direction: detachment of the wall **b** and shear cracks **c'**.



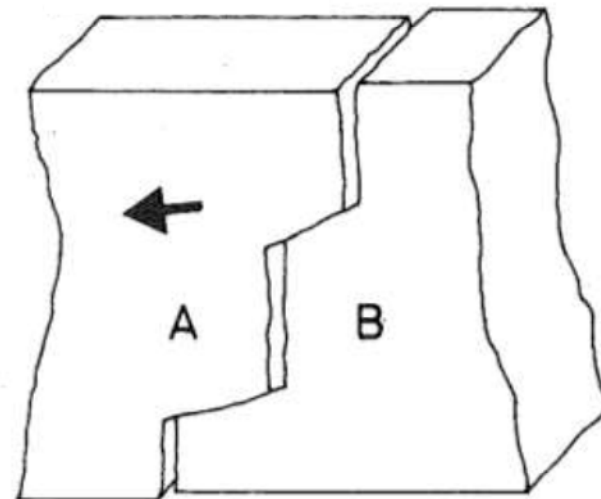
Detachment of a part of the façade due to puncture of the trusses. The corner areas can resist if the orthogonal walls are well connected to each other.



a) Corner damages caused by the action of the diagonal struts in a building with a spine wall; b) from the inertial forces of the wall and from the transverse struts of the roof; c) from the alternating shear actions.

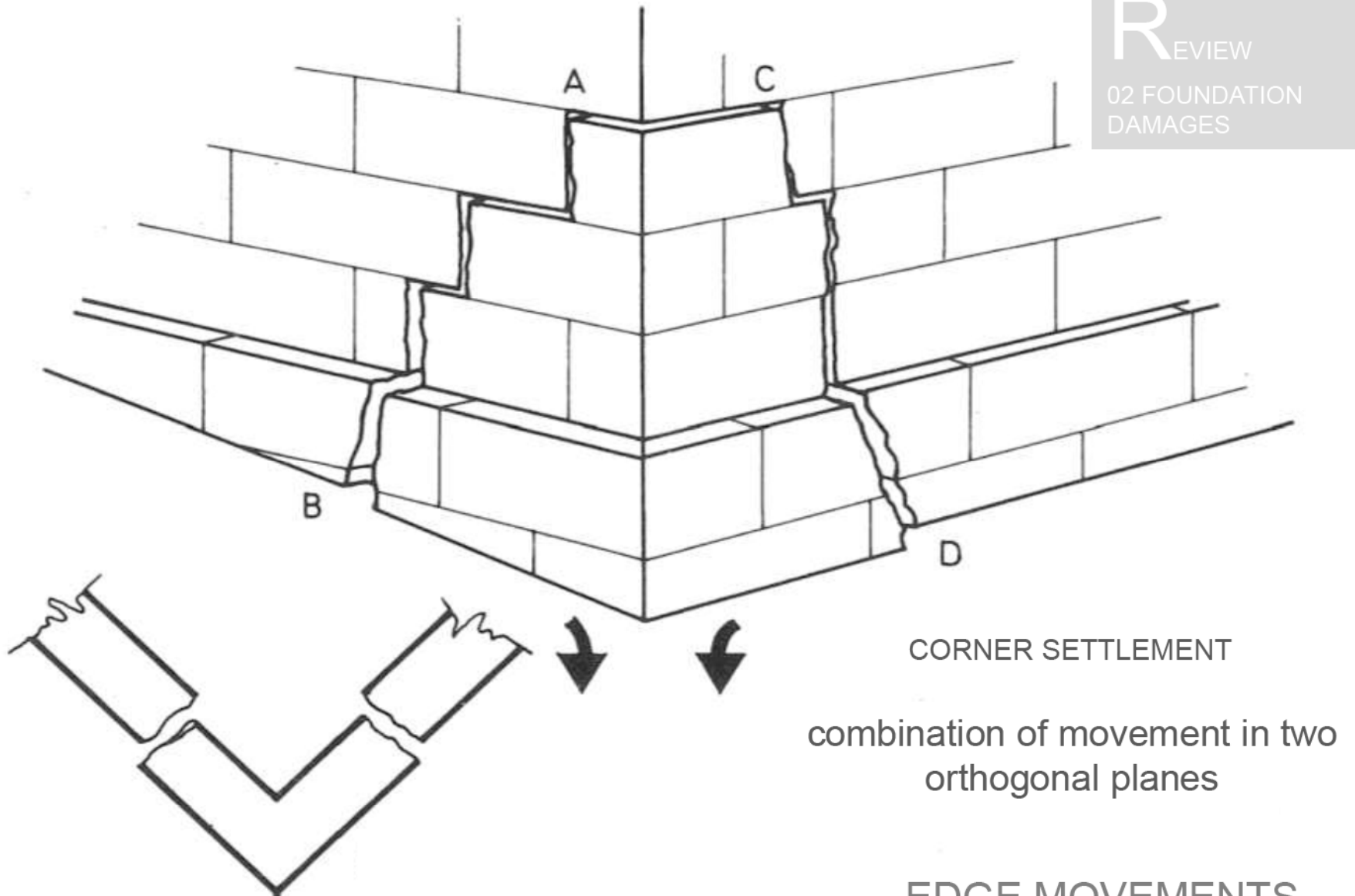


SHEAR AND STEPS CRACKS



EDGE MOVEMENTS

FOUNDATION AND GROUND DAMAGES



CORNER SETTLEMENT

combination of movement in two
orthogonal planes

EDGE MOVEMENTS

FOUNDATION AND GROUND DAMAGES

3. VERIFICATION OF THE HYPOTHESES

- STRUCTURAL ANALYSIS
- RECOGNITIONS

DAMAGE DETECTION

- SURVEYS
- ESSAYS
- INSTRUMENTAL METHODS

05 WALLS II

METHODOLOGICAL APPROACH

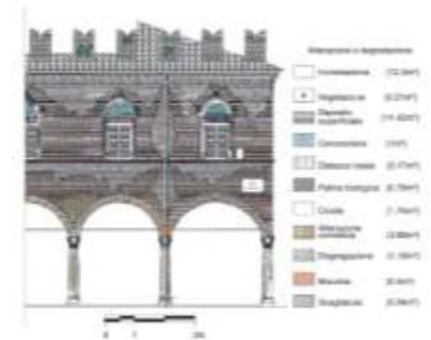
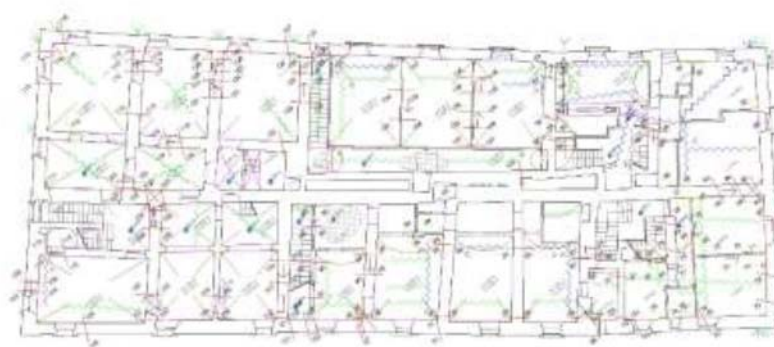
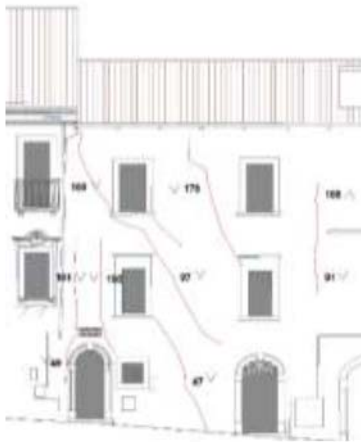
DAMAGE DETECTION

- SURVEYS

- STRUCTURAL TYPOLOGIES
- CONSTRUCTIVE SURVEY
- MAPS OF DAMAGES
- ALTERATION AND DEGRADATION
- MATERICO DETERIORATION
- MECHANICAL SURVEY

REVIEW

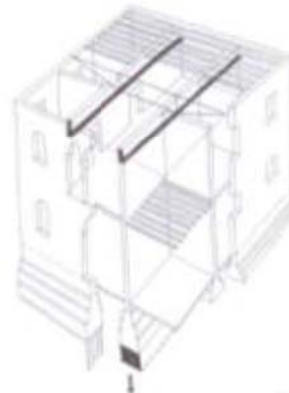
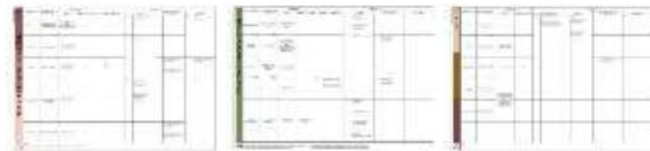
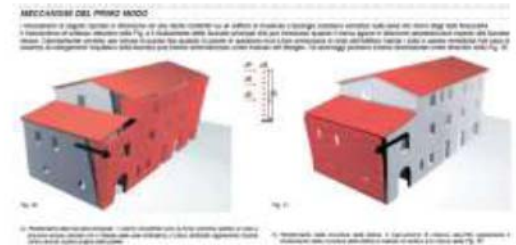
COURSE:
METHODOLOGICAL
APPROACH



DAMAGE DETECTION

- SURVEYS

- STRUCTURAL TYPOLOGIES
- CONSTRUCTIVE SURVEY
- MAPS OF DAMAGES
- ALTERATION AND DEGRADATION
- MATERICO DETERIORATION
- MECHANICAL SURVEY



DAMAGE DETECTION

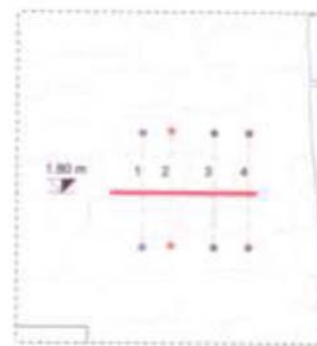
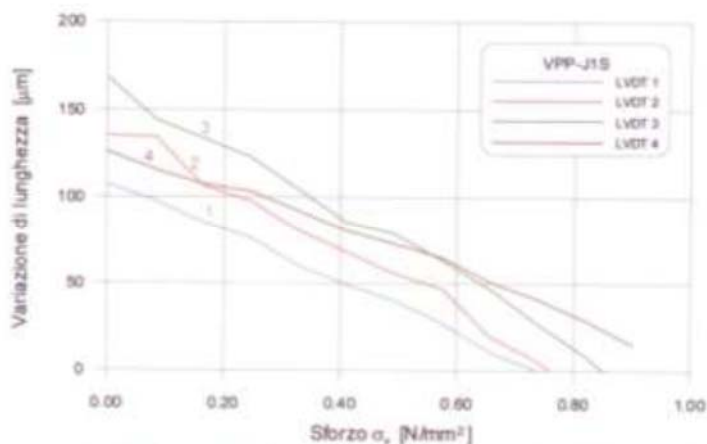
- SURVEYS
- **ESSAYS**
- INSTRUMENTAL METHODS



Lettura degli spostamenti verticali con il martinetto piatto inserito nella muratura



Il sistema idraulico collegato al martinetto inserito nella muratura



Disposizione delle basi di misura

Prova VPP-J15. Andamento della distanza tra le basi di misura in funzione dello sforzo applicato

Prova VPP-J15	
Base di riferimento	SFORZO (N/mm ²)
Base 1	0.74
Base 2	0.76
Base 3	0.85
Base 4	-
Stato di sforzo medio	0.78

Sforzo corrispondente all'annullamento della variazione di lunghezza tra le singole basi (valori interpolati)

**SIMPLE
FLAT-JACK**

**DOUBLE
FLAT-JACK**



11.



12.



13.



A Review on Flat-Jack Testing

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Azurém, P - 4800-058 Guimarães, Portugal*

ABSTRACT

Flat-jack testing is a versatile and powerful technique that provides significant information on the mechanical properties of historical constructions. In this paper, a state of the art about flat-jack testing is presented together with some experiments carried out by the authors. In particular, ASTM and RILEM standards are reviewed and additional recommendations are set forth.

1. INTRODUCTION

Preservation of the architectural heritage is considered a fundamental issue in the cultural life of modern societies. In recent years, large investments were made in this area, leading to developments in inspection, non-destructive testing, monitoring and structural analysis of monuments. Nevertheless, understanding, analyzing and repairing historical constructions remains one of the most significant challenges to the modern technicians.

The analysis of ancient constructions poses important challenges because of the complexity of their geometry, the variability of the properties of traditional materials, the different building techniques, the absence of knowledge on the existing damage from the actions which affect the constructions throughout their life and the lack of codes. In addition, restrictions in the inspection and the removal of specimens in buildings of historical value, as well as the high costs involved in the inspections and diagnoses, often result in reduced information about the internal constructive system or the properties of the existing materials.

Non-destructive methods are, in fact, necessary to obtain the mechanical characteristics needed for the analysis and understanding of the mechanical behavior of historical constructions, as well as, to validate the analysis itself.

2. A STATE OF THE ART ABOUT FLAT-JACK TESTING

Engineers involved in structural analysis of existing historical structures need information about the compressive stresses, the deformability properties and the loads applied

¹ Associate Professor (pbl@eng.uminho.pt)

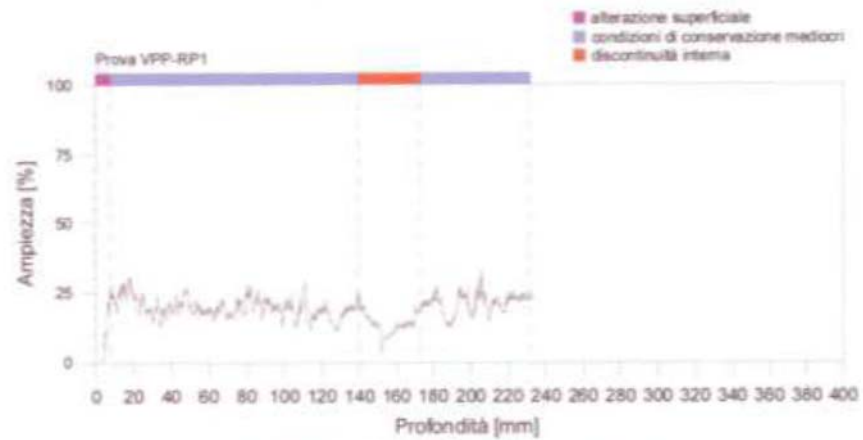
² Socrates exchange student



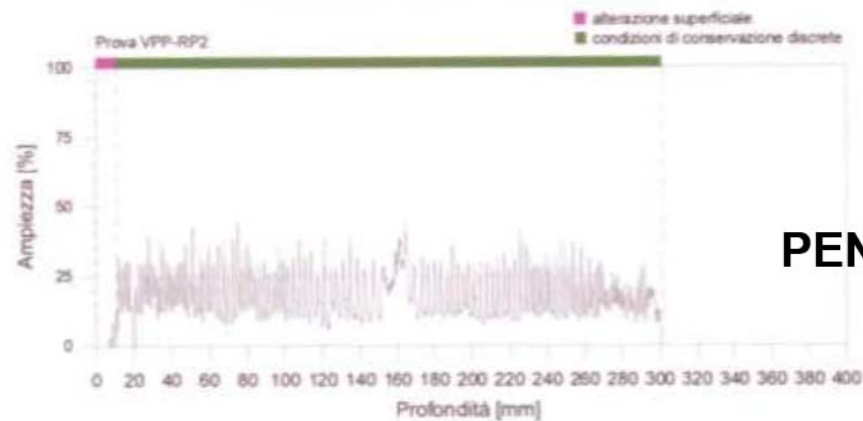
Lettura dell'umidità interna alla trave 14



Esecuzione della prova penetrometrica



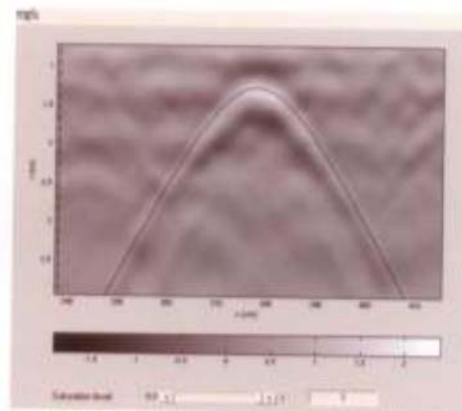
Profilo densimetrico ottenuto dalla prova VPP-RP1



PENETROMETER



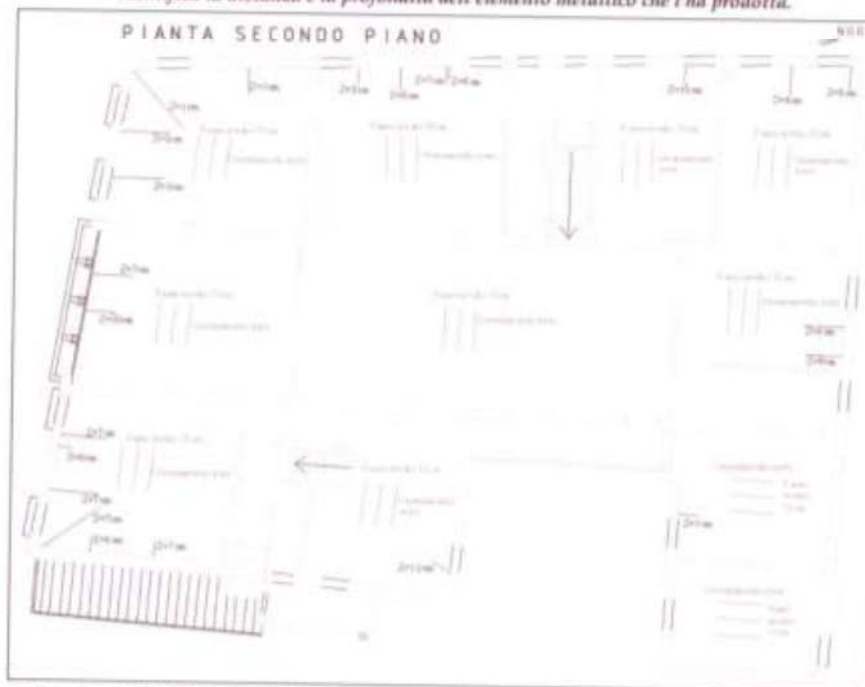
Esecuzione delle indagini al 2° piano di palazzo Pisani tramite GPR con antenna da 2 GHz a doppia polarità



Elaborazione di un tracciato radar: analisi di velocità condotta sulla diffrazione prodotta da una fiuba



Esempio di dati elaborati in cui si osservano 3 diffrazioni. La posizione del vertice identifica la distanza e la profondità dell'elemento metallico che l'ha prodotta.



Localizzazione delle fiube, non visibili dall'esterno, e orientamento delle travi del solaio di secondo piano a Palazzo Pisani. Si può notare un orientamento coerente con quello atteso, che varia solo nell'ala Nord-Est

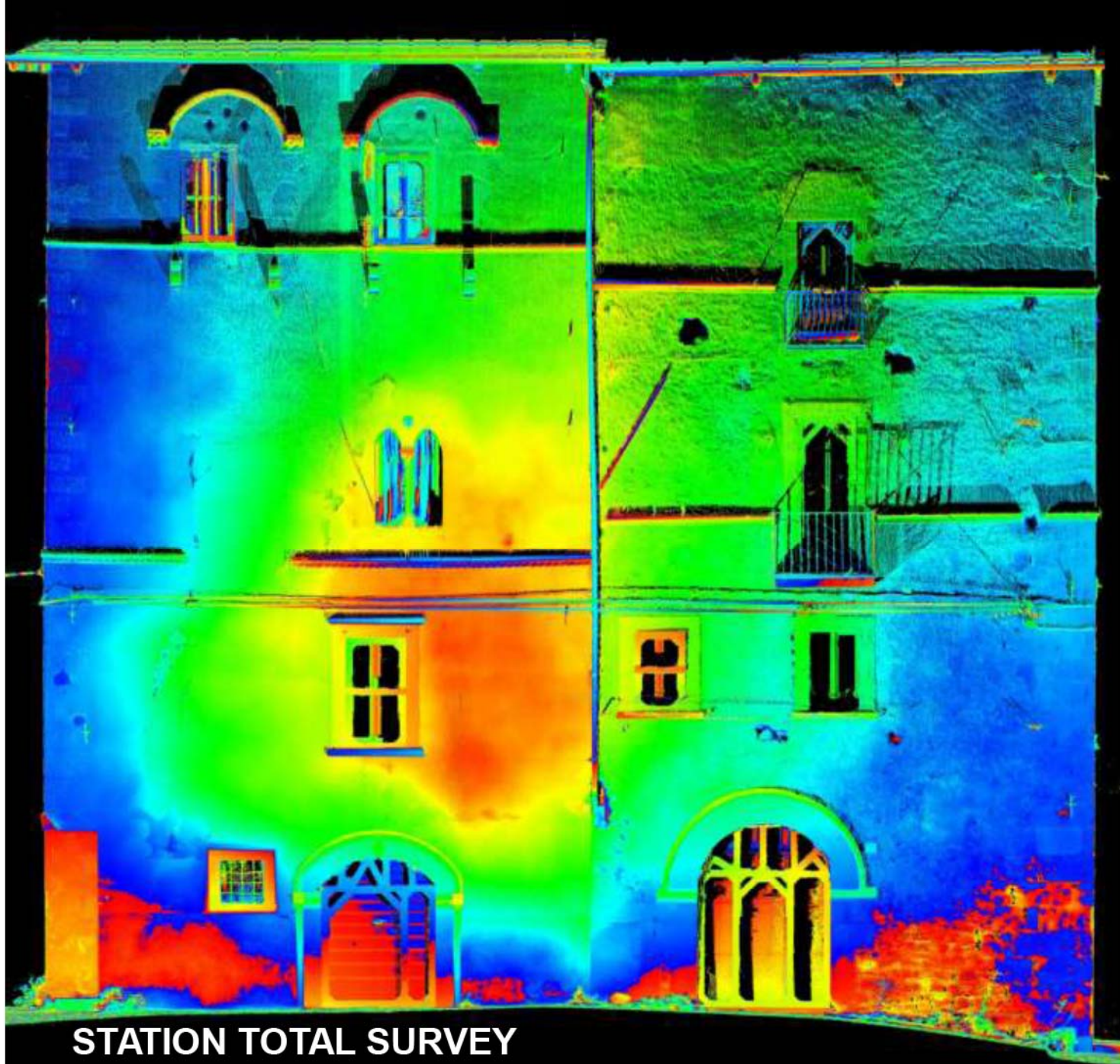
GEORADAR

DAMAGE DETECTION

- SURVEYS
- ESSAYS
- **INSTRUMENTAL METHODS**



ENDOSCOPE



STATION TOTAL SURVEY
deformations

CAUSES

- INCOMPATIBILITY (CONSTRUCTIVE)

- WATER

- RAIN
- SOIL (CAPILARITY)
- CONDENSATION

- GROUND

- SOIL SETTLEMENT
- EARTH PRESSURE
- CHANGES

05 WALLS II

CAUSES

CAUSES (II)

- STRUCTURAL

- ORIGINALLY
- JOINTS

- BIOLOGICAL AGENTS

- CONTAMINATION

- HUMAN ACTION

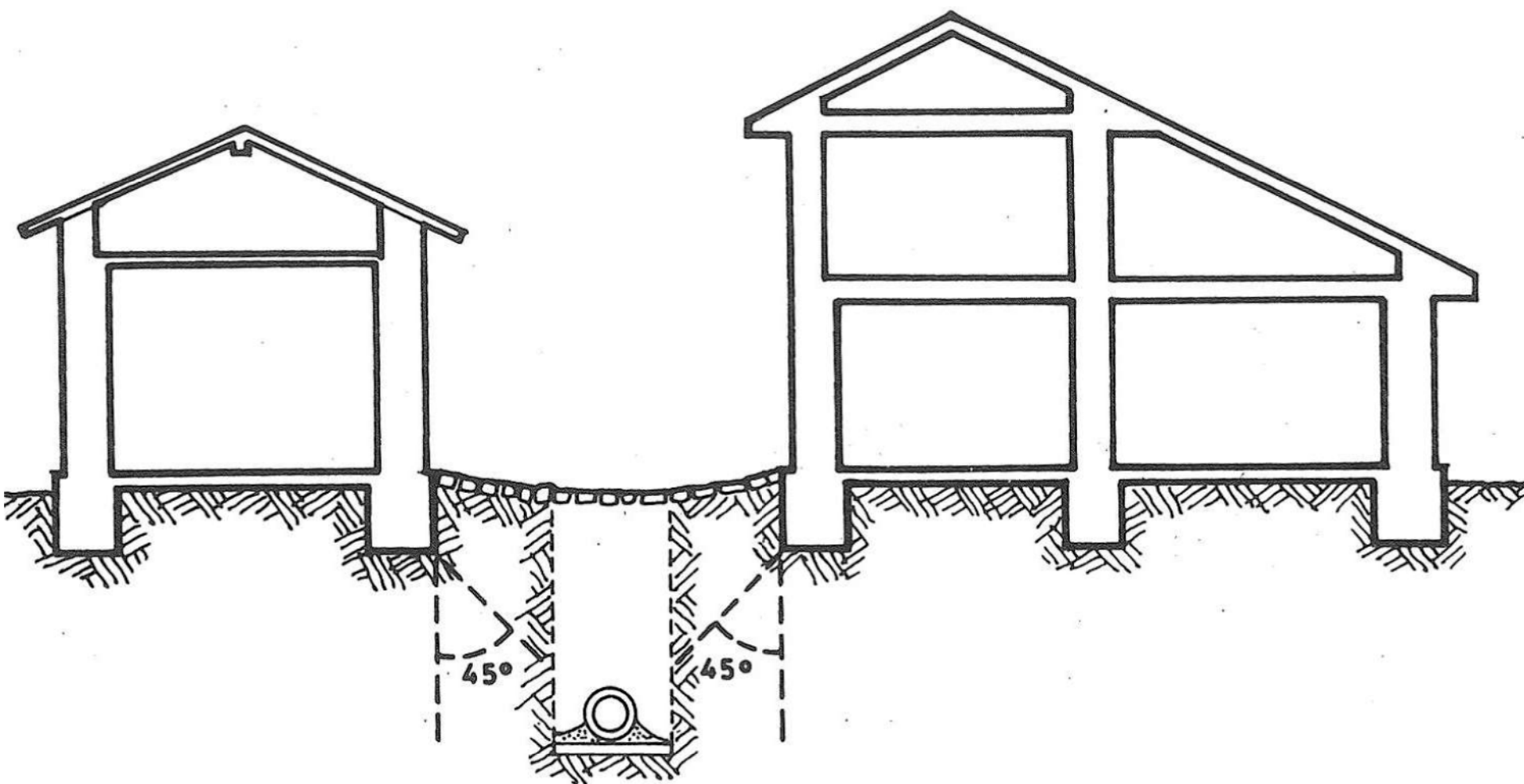
- THERMAL

- MATERIALS

- DEGRADATION
- OXIDATION

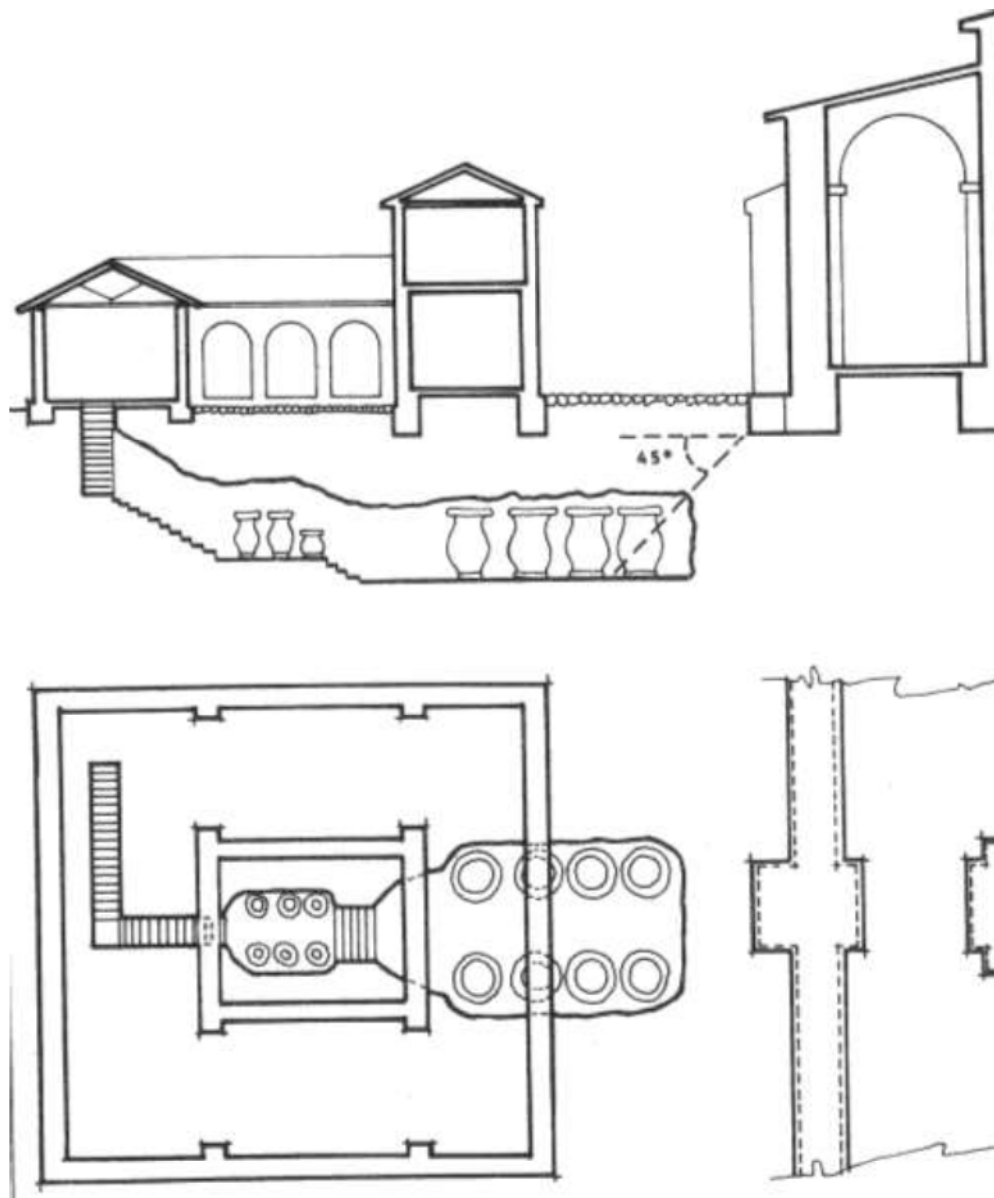
05 WALLS II

CAUSES



EXCAVATIONS, PAVING, SANITATION, WELLS, CELLARS...

MODIFICATIONS OF THE ENVIRONMENT



EXCAVATIONS, PAVING, SANITATION, WELLS, CELLARS...

MODIFICATIONS OF THE ENVIRONMENT



**Project "SURE - Sustainable Urban Rehabilitation in Europe"
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Key Action 2: Strategic Partnership Projects
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