

INTERNATIONAL SYMPOSIUM ON SEISMIC RETROFIT OF UNREINFORCED MASONRY CHURCHES OF THE PHILIPPINES

National Museum Auditorium, Manila, Philippines

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Conditions Survey

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What I am going to talk about today

- Introduction
- General Concepts in Building Diagnostics
- Visual Condition Survey of the Bohol Churches



Can buildings speak?







The Importance of Time in Diagnoses

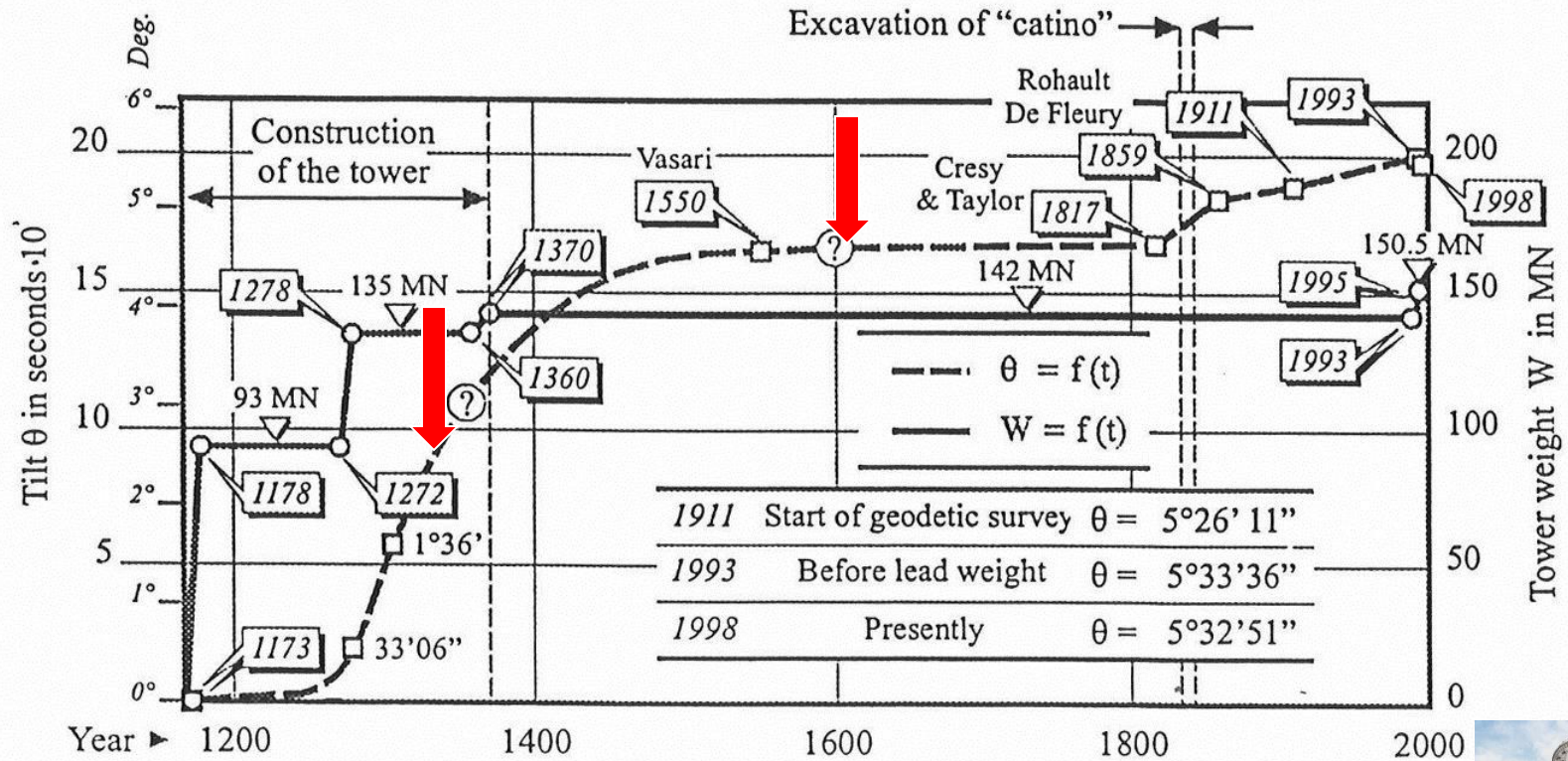


Fig. 1 - Evolution of Rigid Tilt with Time



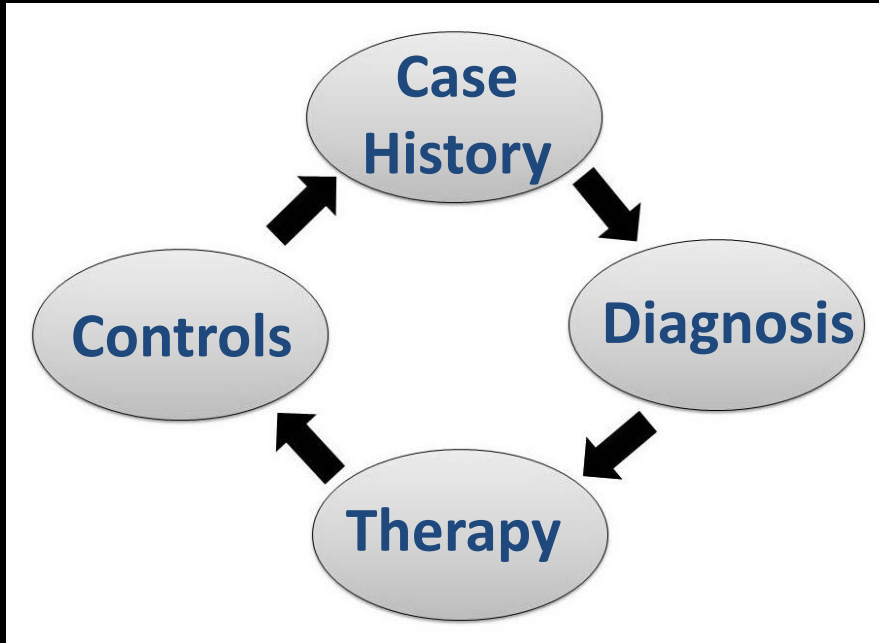


Key Concepts in Building Diagnostics

The uniqueness of older structures with their complex histories, requires the organization of studies in steps that are similar to those used in medicine. **Case history, diagnosis, therapy and controls**, corresponding respectively to the search for significant data, categorizing the causes of deterioration and decay, choosing treatments, and monitoring the effectiveness of those treatments.



The Medical Analogy



Case History: The known history of a building including past traumas, interventions, modifications, etc.

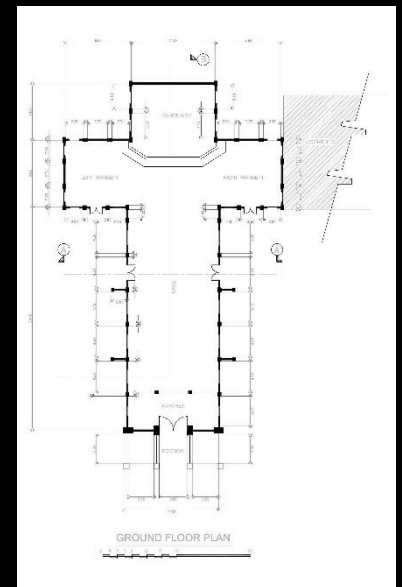
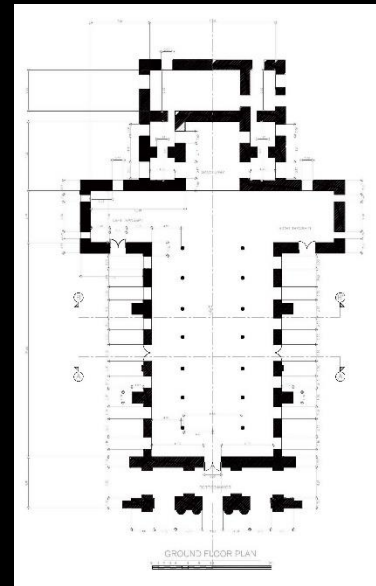
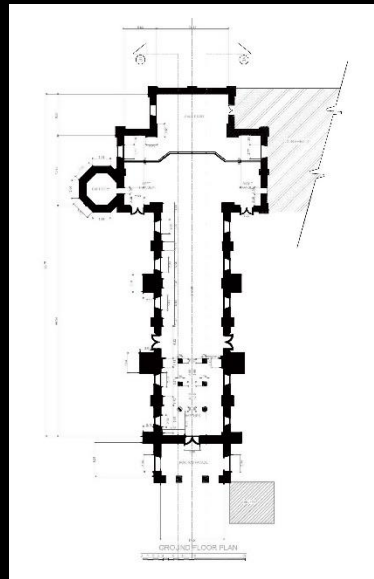
Diagnosis: Identifying or determining the nature and causes of deterioration and decay, and the opinion derived from such an investigation.

Repair: The remedial measures (conservation, preservation, rehabilitation, etc.) in response to the diagnosis.

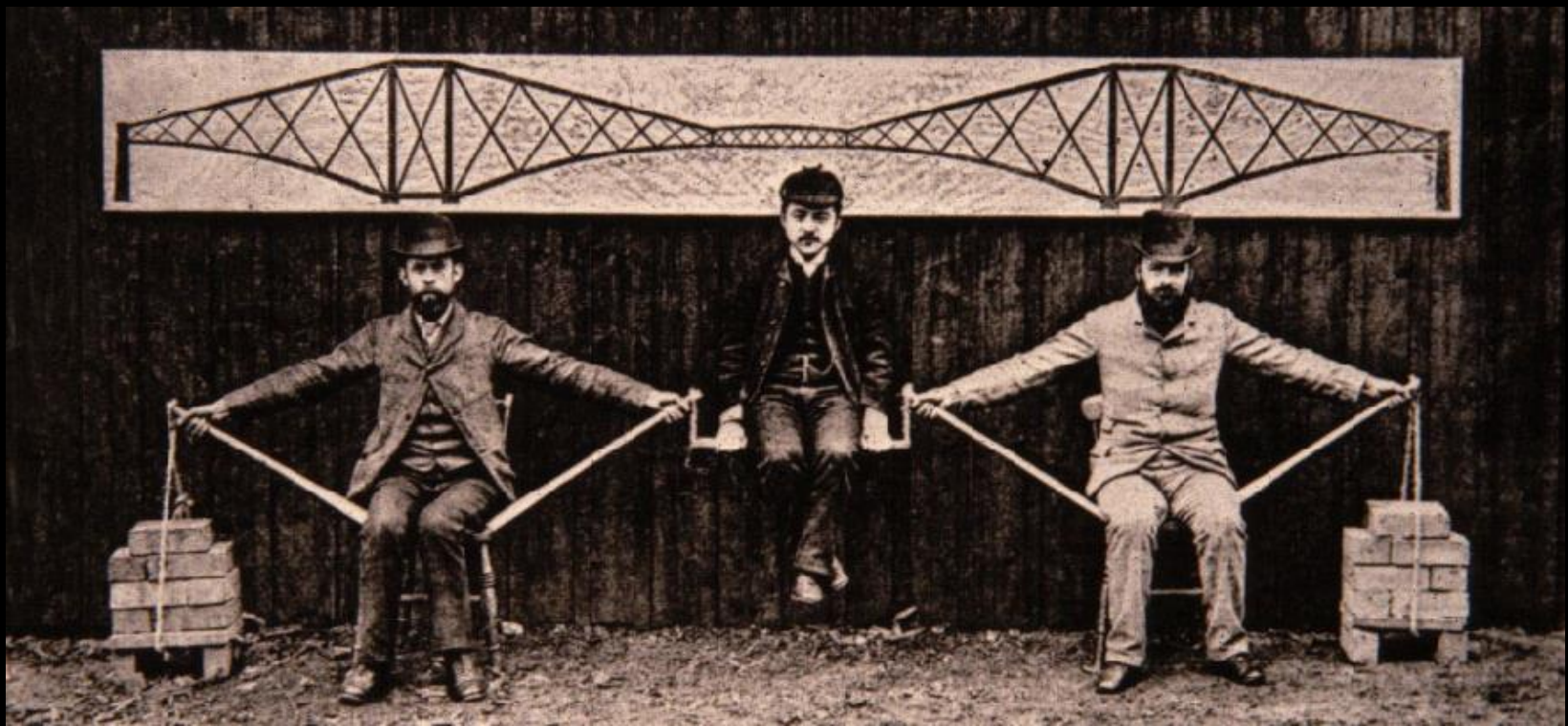
Controls: verifying and regulating the efficiency of an enacted therapy through monitoring and cyclical examination.

Building Types – Materials and Systems

the systematic organization of buildings and building materials and systems into types on the basis of shared attributes.

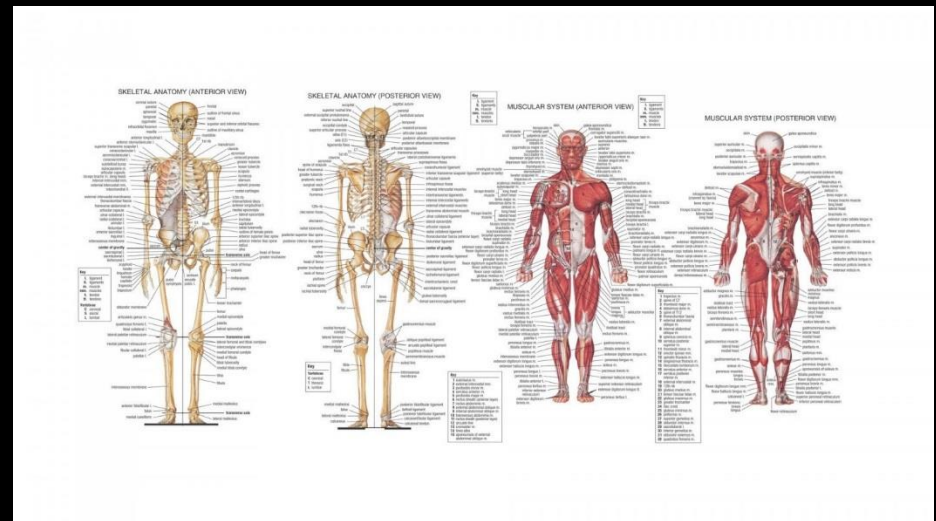


A full understanding of structural and material characteristics is required. Information should be gathered on its original and earlier states, construction techniques, alteration and their effects, and its present state.



Building Systems

- **Structural for Gravity and Lateral Forces**
 - Interaction with the ground
- **Envelope**
 - Roofing Systems
 - Wall Systems and windows
- **Interior Finishes**
- **Comfort Systems**
 - Natural
 - Man-made



Forces acting on a structure

Static forces - Gravity loads, soil settlements, deformations produced from thermal variations, creep, shrinkage, etc.

Dynamic forces- produced when accelerations are transmitted to a structure, due to wind, hurricanes, vibrating machinery, earthquakes, etc.

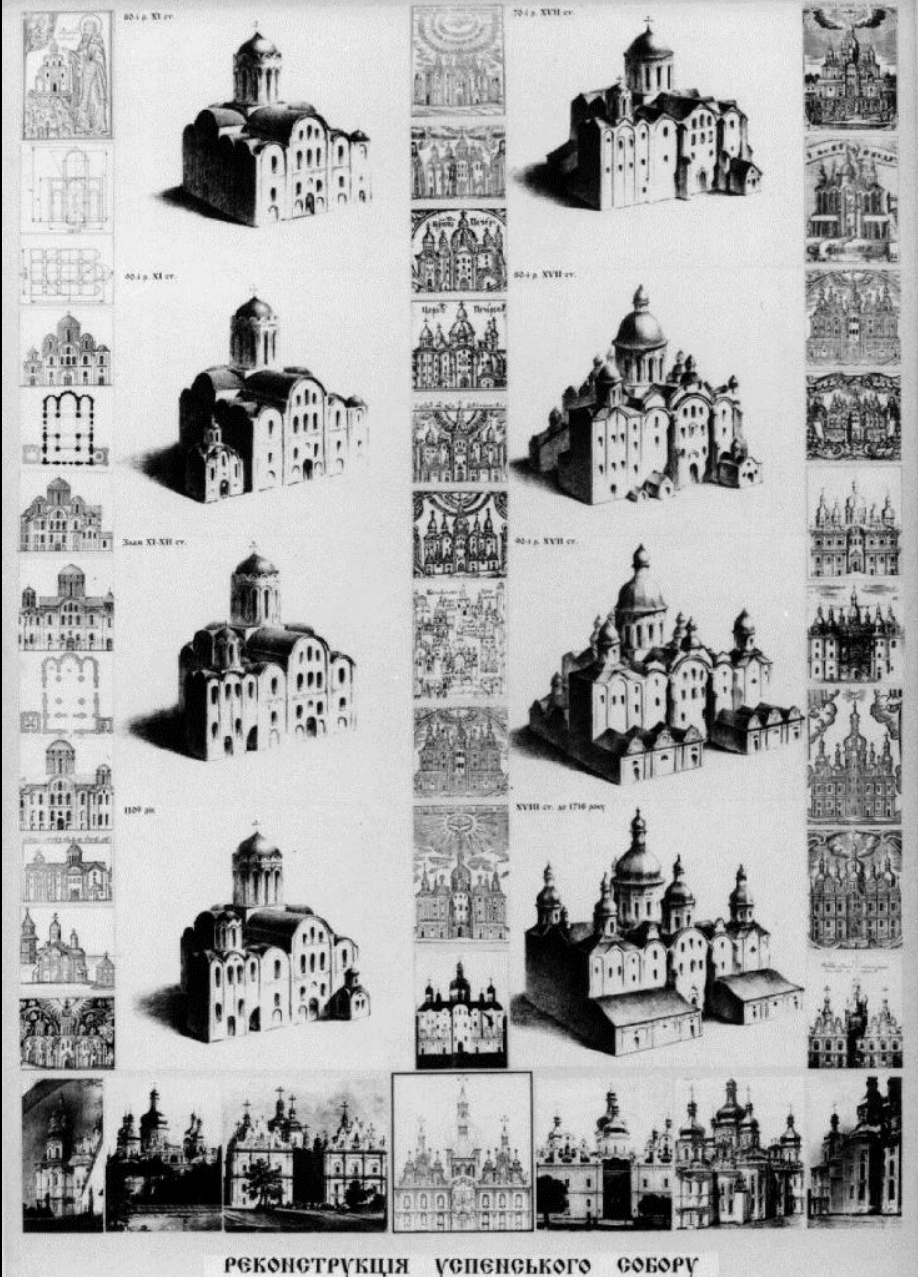
Chemical, physical and biological forces - Decay phenomenon of the materials of the structure.

Ways of obtaining data (i.e. investigation)

- Review of archival data
- Physical non-invasive survey
- Physical invasive survey
- Field and laboratory testing
- Long Term monitoring

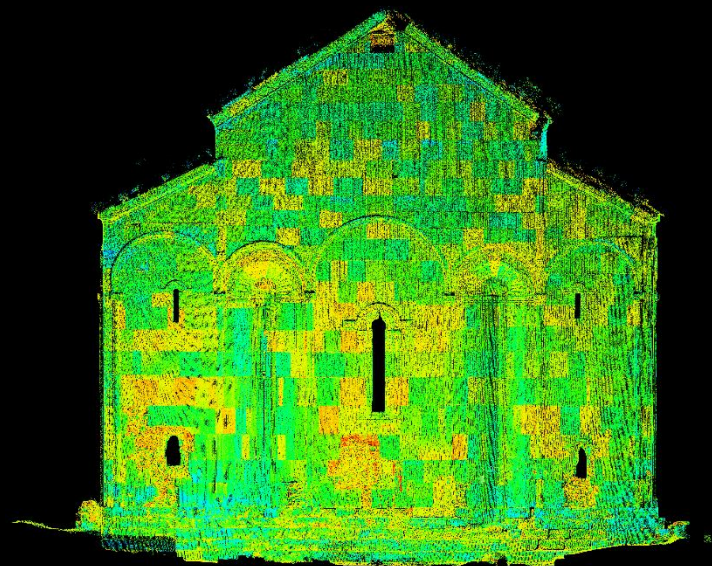
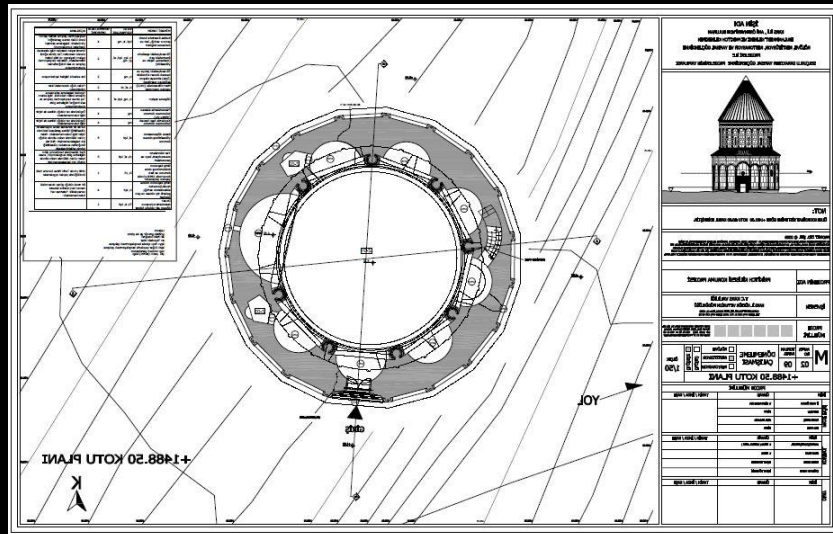
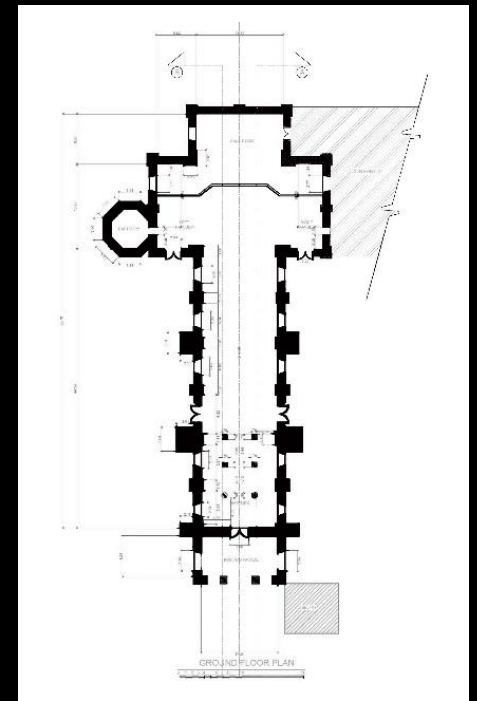
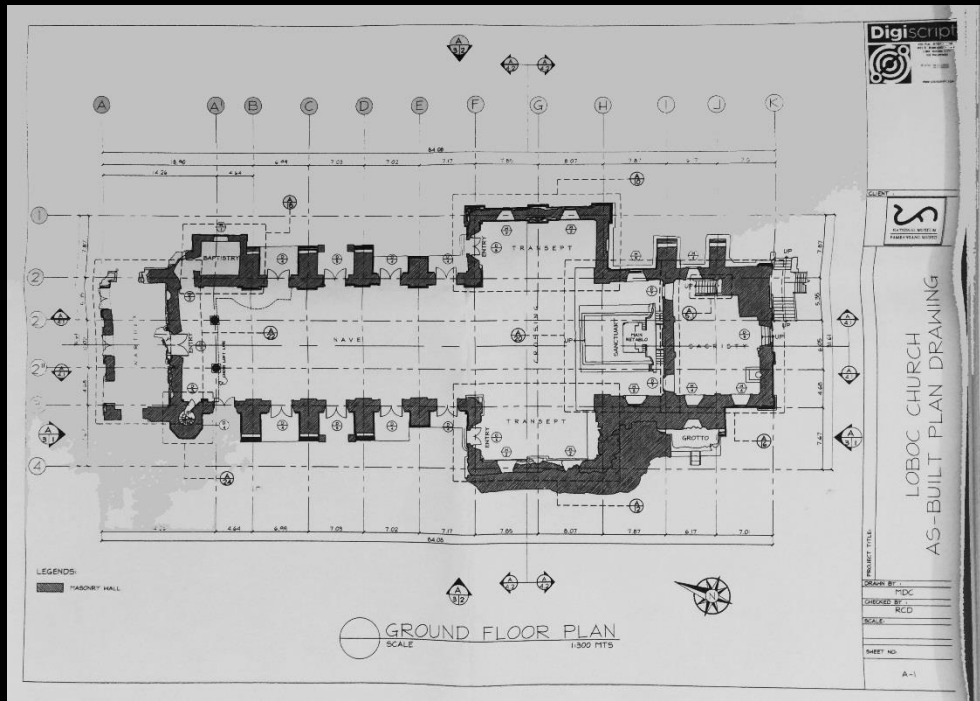


Review of archival data



Physical Non-invasive Survey

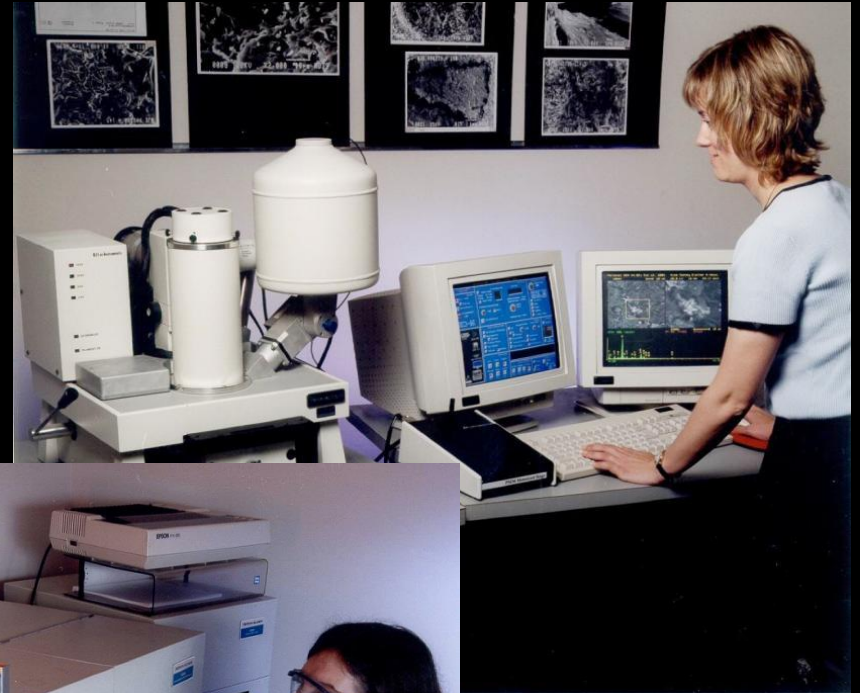




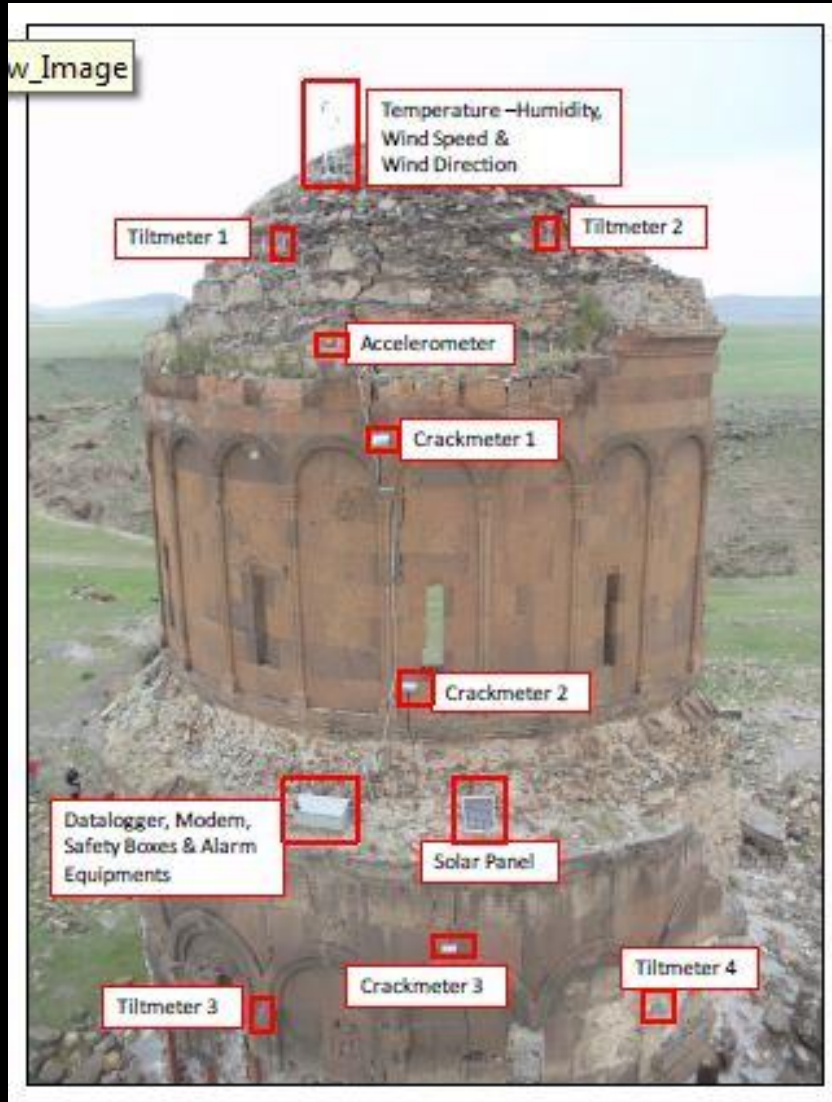
Physical Invasive Survey



Field and Laboratory Testing



Long Term Monitoring

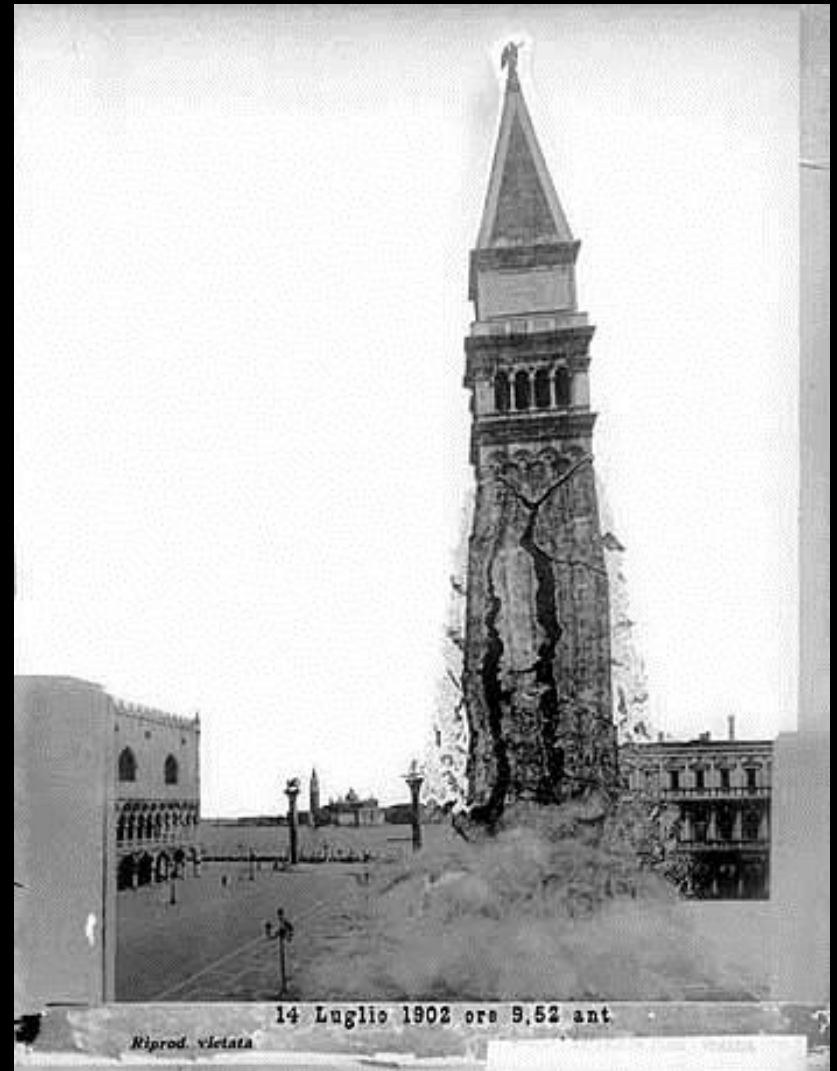


Types of Diagnoses

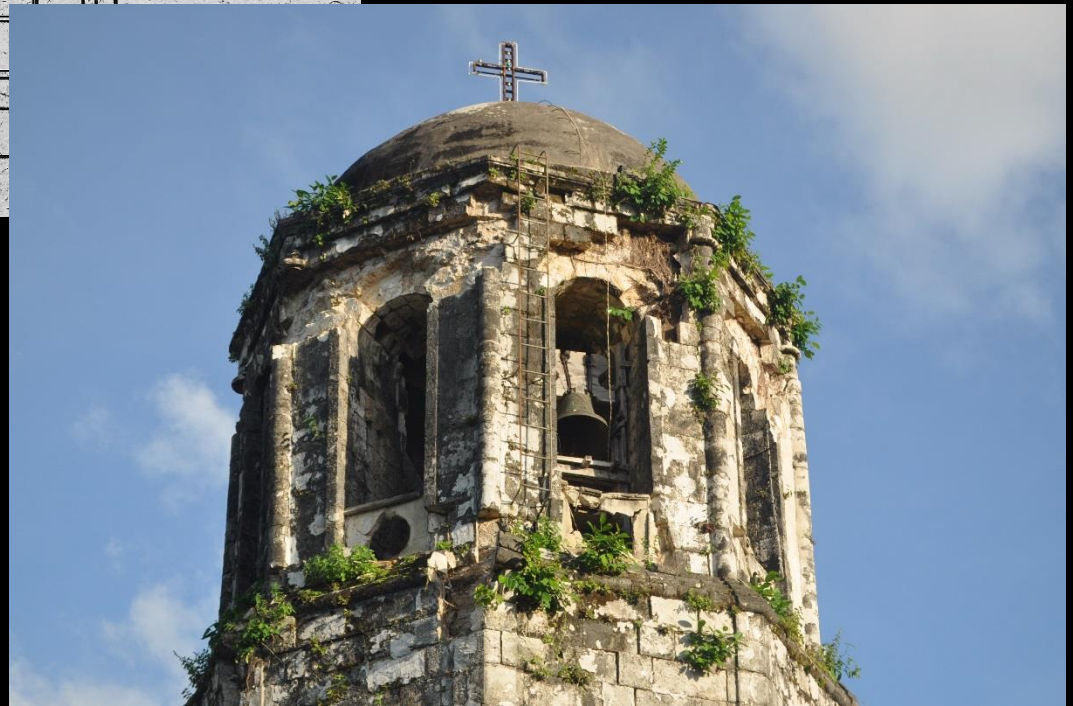
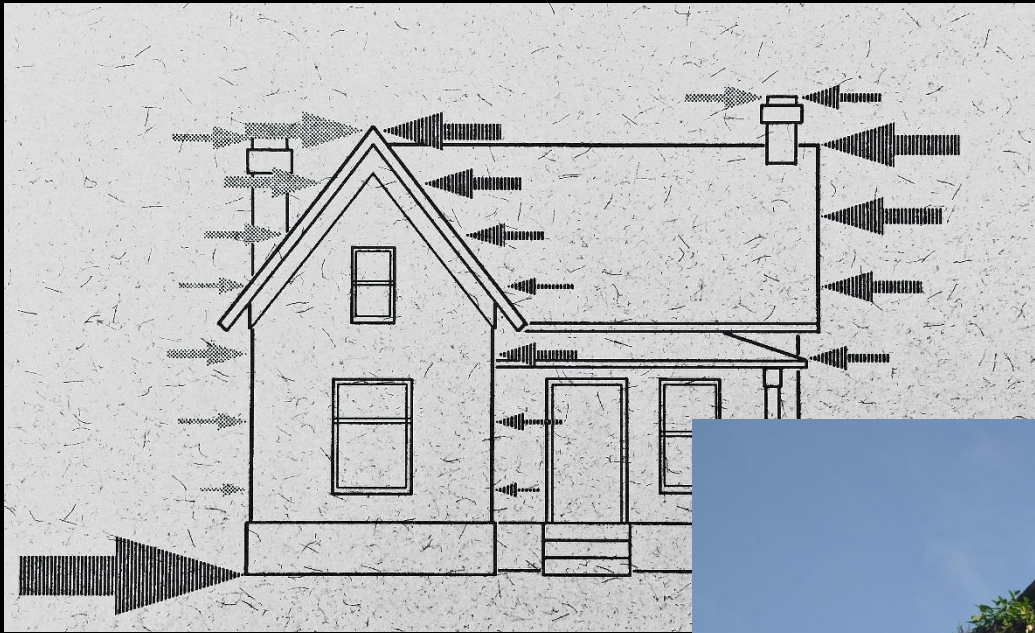
- Intuitive
- Inductive
- Deductive



Intuitive (based on instinct)



Inductive (based on past experience)



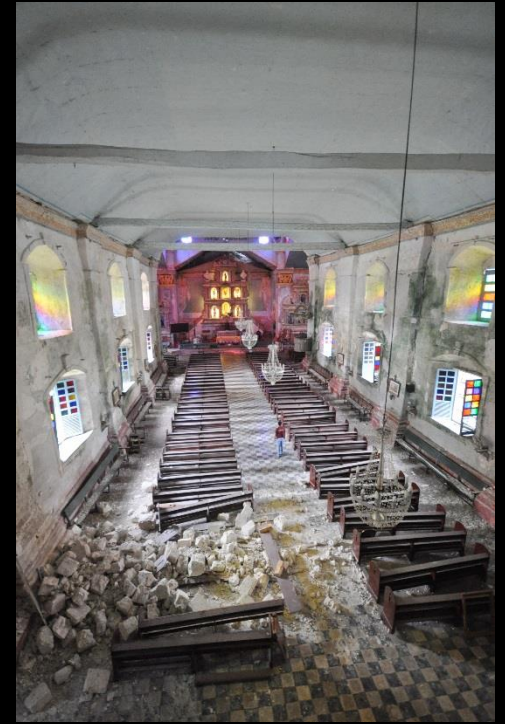
- **Deductive (quantitative, analytical, based on experimentation)**



- **Deductive**



Visual Condition Survey of the Bohol Churches



Principal factors that influence building damage in an earthquake:

- strength of earthquake
- duration of the earthquake and tremors
- proximity of the building to the epicenter
- geological and soil conditions
- building typology and materials
- building condition

Unreinforced Masonry Walls

- They are brittle with limited deformability.
- They rely on friction, overburden from supported loads and wall weights.
- They often have highly variable material properties.
- They are vulnerable to incremental damage, particularly in strong earthquakes of long duration with multiple aftershocks.

Cortes













Loay











Baclayon















Alburquerque





Loboc













Roofing Systems











Salamat!

