3DVDT

Scan to BIM Solutions

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Nondestructive Testing and Evaluation (NDT)

Combining Terrestrial Laser Scanning
&
Infrared Thermography

Case Studies

Why use both NDT technologies for testing/evaluation of historic structures?

3D Laser Scanning:

- Real-time, geometric measurement
- Defines a reference for structural monitoring
- Detects residuals / intensity of reflection from the surface

Infrared Thermography:

- Identify anomalies
- Cost effective thermal cameras
- 2D data acquisition

Infrared Thermography (IRT):

A contactless and visual temperature measurement technology.

Infrared Camera:

A non-contact device that detects infrared energy (heat) and converts it into an electronic signal, which is then processed to produce a thermal image on a video monitor and perform temperature calculations.

Terrestrial Laser Scanning (TLS):

A contactless and visual laser measurement technology, whereby each point represents a 3D coordinate.

Point Cloud:

A collection of data points defined by a given coordinate system (3D data set).

Information from each recorded point:

- Position, as a set of coordinates
- Reflectance, as a ratio between the emitted and reflected phases of the laser wave.

- ✓ Building Facade Maintenance
- ✓ Building Efficiency
- ✓ Building Conservation
- ✓ Building Assessment after Disaster

✓ Building Facade Maintenance

Administration Bulletin AB-110 signed by the Director of the San Francisco Department of Building Inspection to establish policies for implementing the SF Existing Building Code Chapter 4E regarding building facade inspection and maintenance.

Inspection Procedures

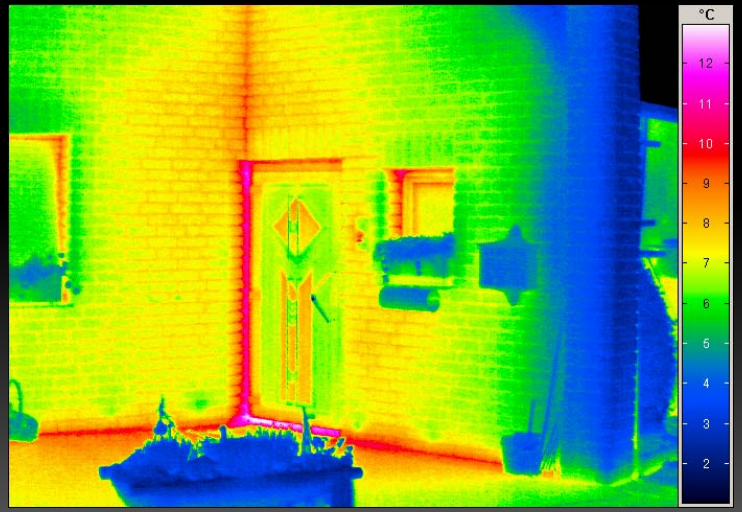
E. Remote sensing techniques, including 3D survey may be proposed by the qualified professional . . .

Inspection of Historic Resources

2. Inspection methods for historic resources shall use the least intrusive or invasive means feasible to effectively assess hidden conditions.

✓ Building Efficiency

The ability to visualize heat makes thermography a powerful tool for studying energy efficiency. Excessive levels of heat loss through a structure and/or damage are easily located with further investigation required to determine the cause (e.g. poor insulation, air leakage, moisture damage)



✓ Building Assessment after Disaster

Case Study: South Napa Earthquake

Of the approximately 1,900 tagged buildings, around 700 are “historic”.

✓ Building Conservation

St. Augustine Monumental Compound

Coscenza, Italy

Located in the historical center of town, the monastery built in 1507 had suffered extensive damage from earthquakes, fire and subsequent seismic events.

Article by: Antonio Costanzo, Mario Minasi, Giuseppe Casula, Massimo Musacchio and Maria Fabrizia Buongiorno

Instituto Nazionale di Geofisica Terremonti, Bologna, Roma, Italy

Case Study

Overlaying and comparing the collected data using a combination of 3D laser scanning (TLS) for 3D reconstruction and Infrared Thermography (IRT) to detect the thermal anomalies aimed to realize a monitoring system of monumental buildings in seismic areas and to analyze the vulnerability of the structural elements.

Methodology

TLS was used to define accurate:

- geometry of the building;
- spatial position;
- geometric dimension of all structural elements.

Some architectural elements were scanned at a higher resolution and some were meshed for a more realistic representation.

Observation

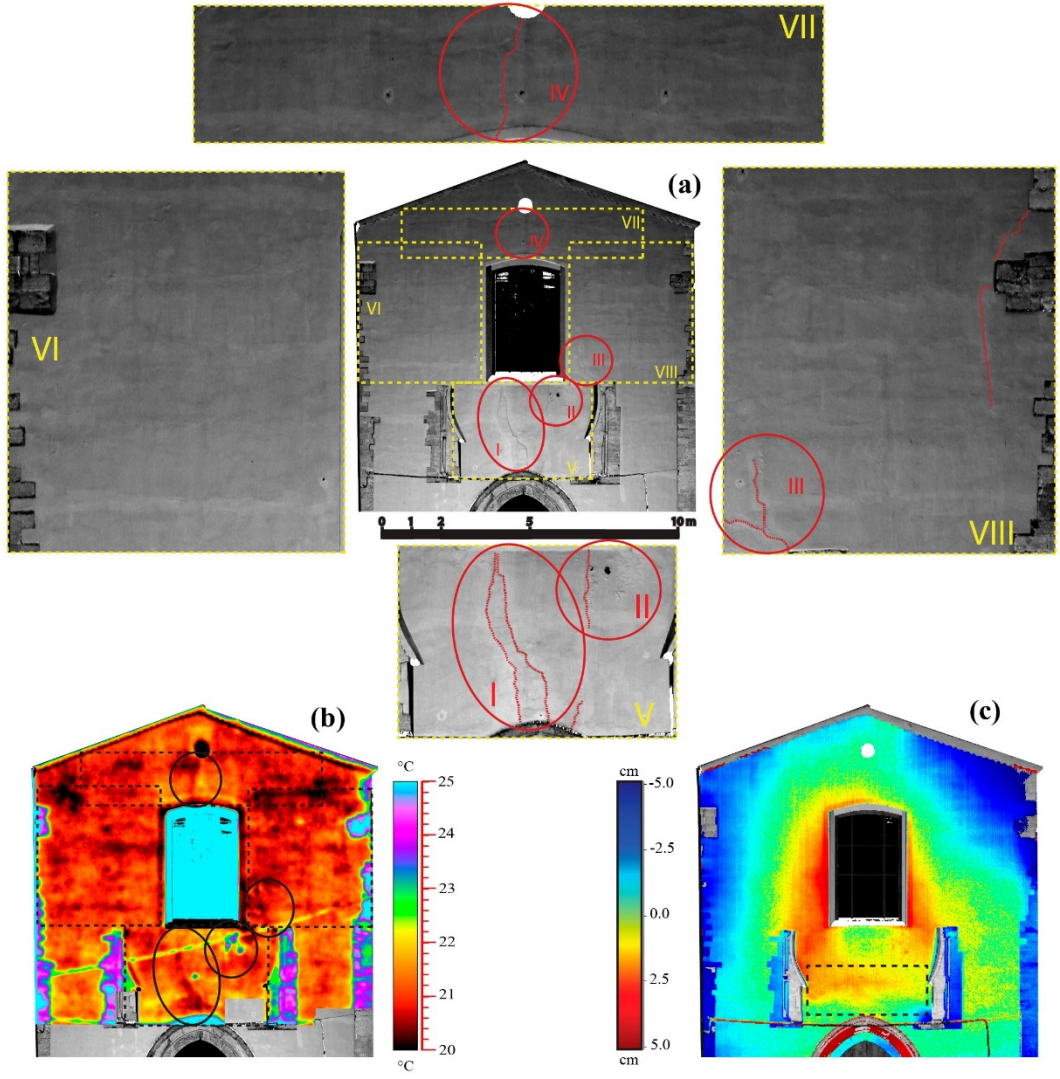
Anomalies barely visible to the naked eye are detected.

a) 3D mesh

b) Thermal image projected over the mesh.

c) Intensity of surface reflection mapping residuals.

I. Detaching of the plaster
II. Swelling of plaster
III. Cracks



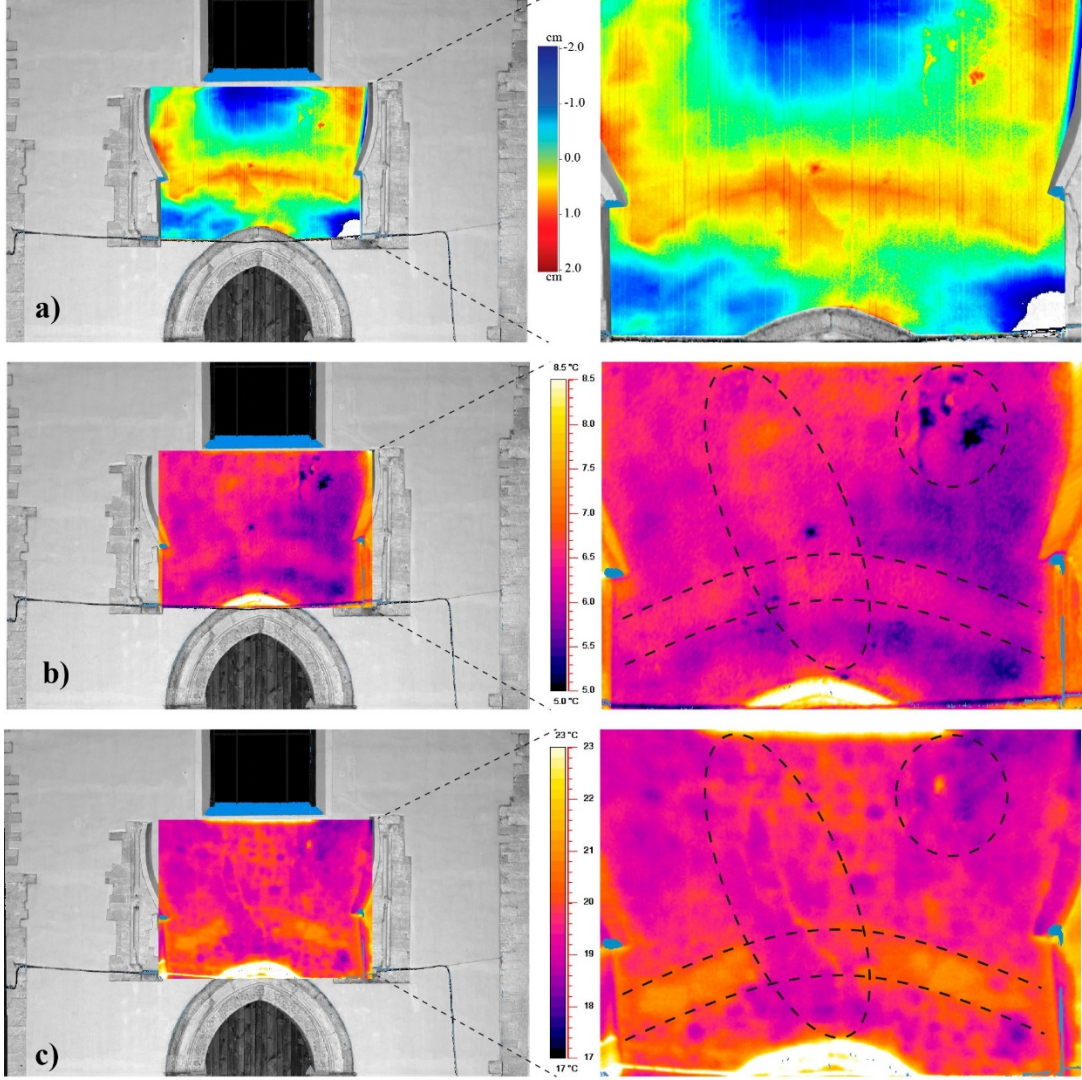
Observation

a) The map of residuals assumes the shape of a segmental arc linking the two columns.

b) Thermal image obtained in the evening.

c) Thermal image obtained in the morning.

Different lighting conditions can influence the detection of anomalies.

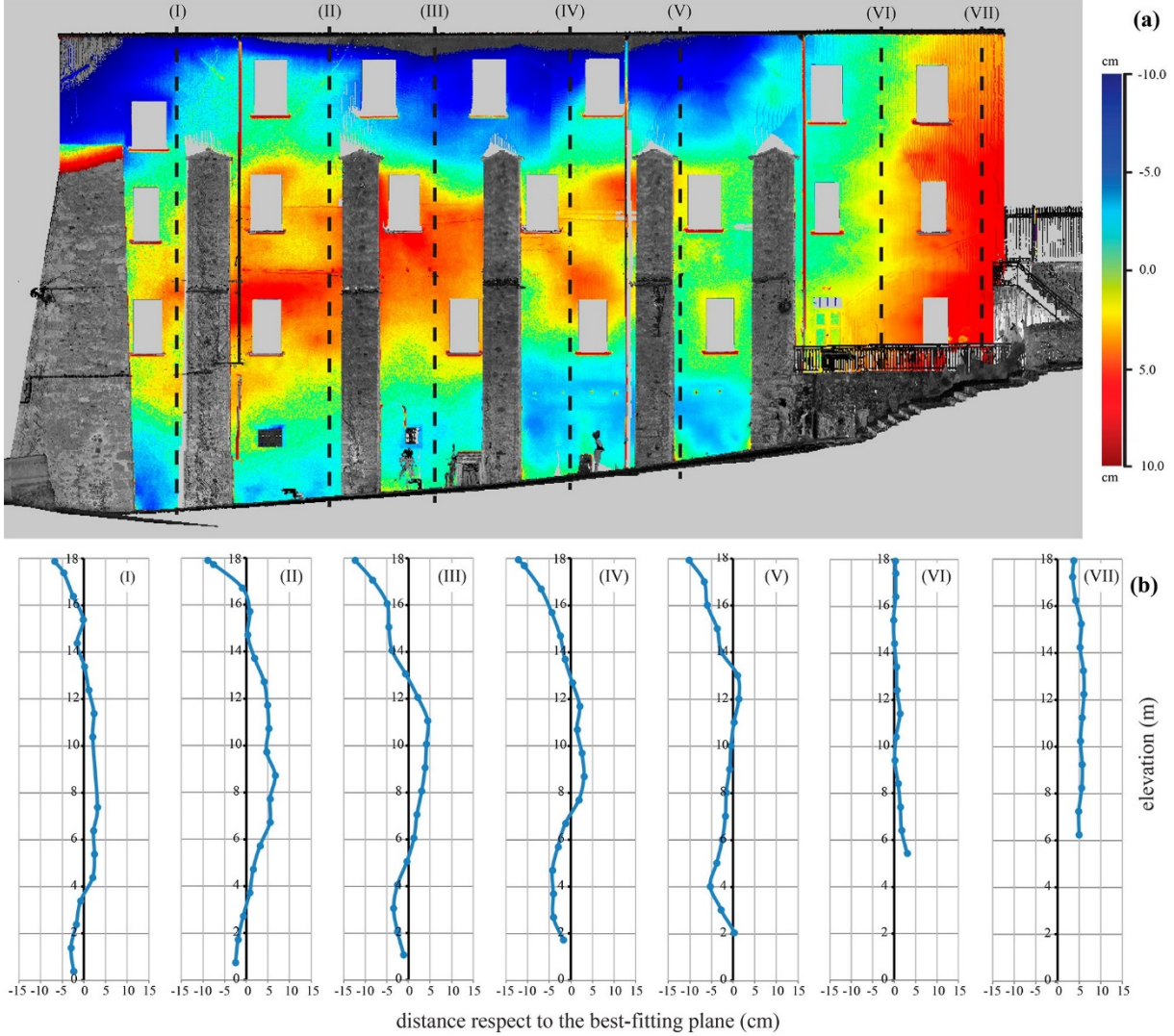


Observation

a) Point cloud and map of residuals of the exterior wall.

b) Vertical profiles of the distance out of plane.

The temperature analysis demonstrates high local differences in the masonry.



Observation

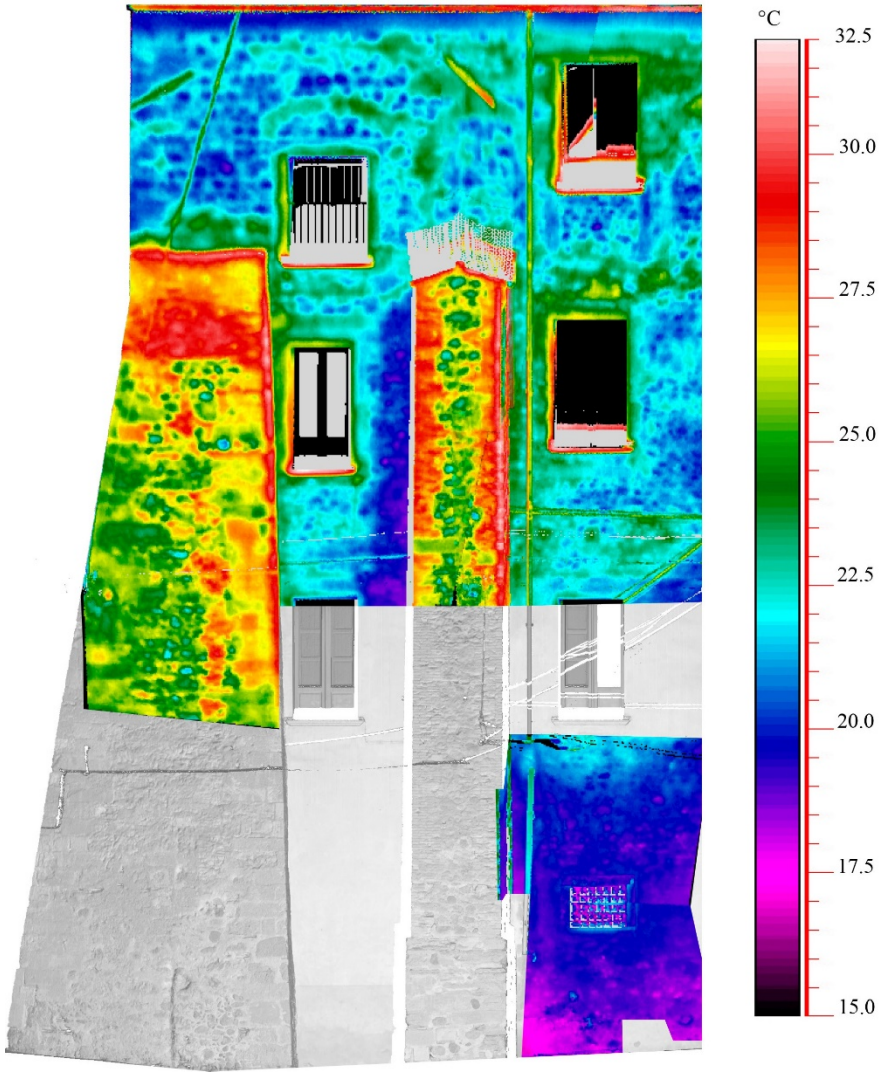
Thermograms projected onto the point cloud of the wall, constructed with stones covered by plaster.

The buttresses are made up of composite material containing both stones and brick.

Evaluation:

- Structural strength
- Period built
- Alterations

The lower right of the wall shows the presence of moisture due to the capillary rise of water from the subsoil.



Observation

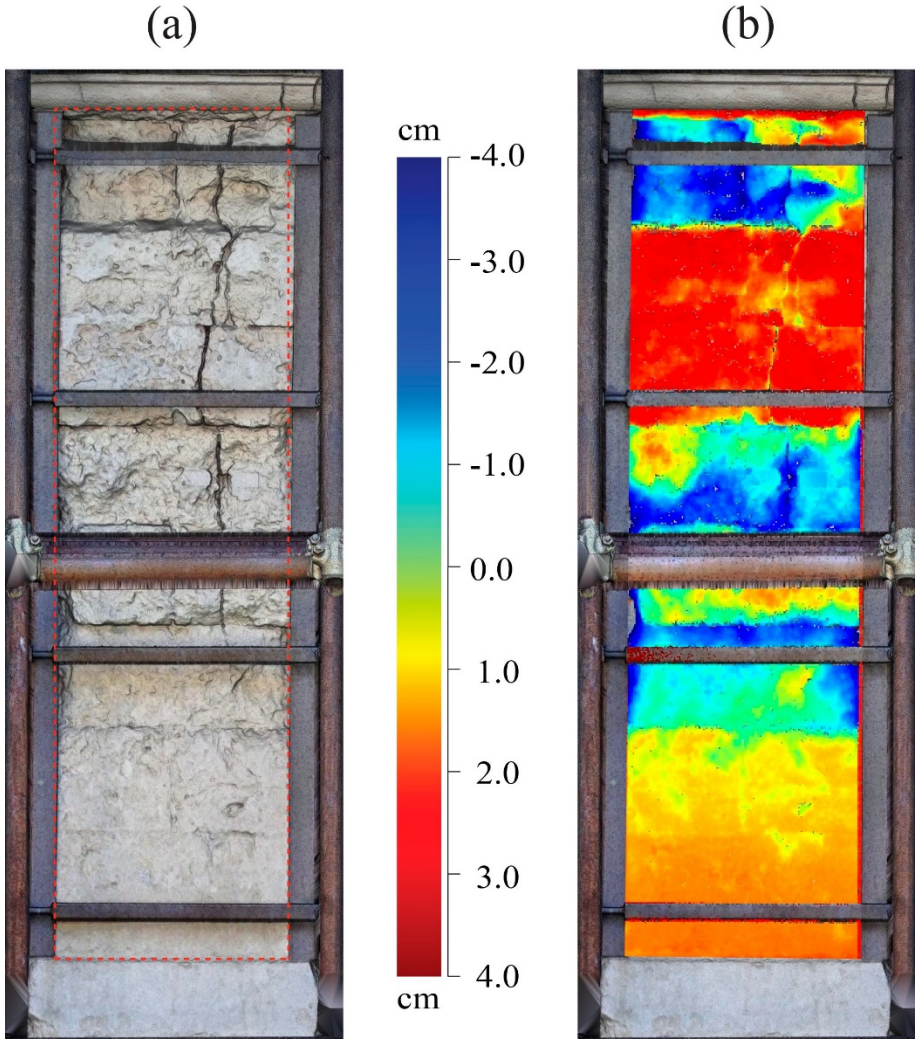
a) 3D mesh at high resolution.

b) Point cloud and map of residuals of one of the most damaged columns.

The cracks are measurable from the point cloud.

The variable degradation of the stone material is indicated by the color scale.

The more degraded zones of the stone blocks are indicated by the blue areas.



Case Studies: South Napa Earthquake 2014

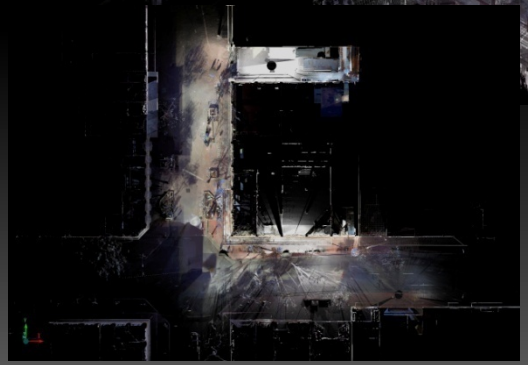
We can use 3D imaging technology for developing preservation strategies for post-disaster public safety recovery and reconstruction methods.

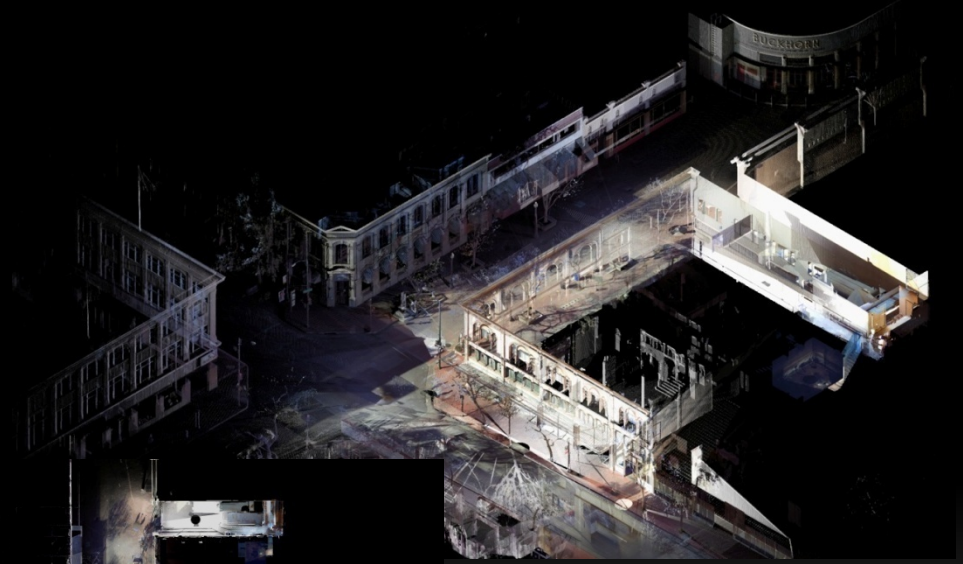
- Historic Gordon Building
- Historic Center Building
- Historic Goodman Library

National Landmark - Gordon Building, Napa, CA

West Elevation

South Elevation



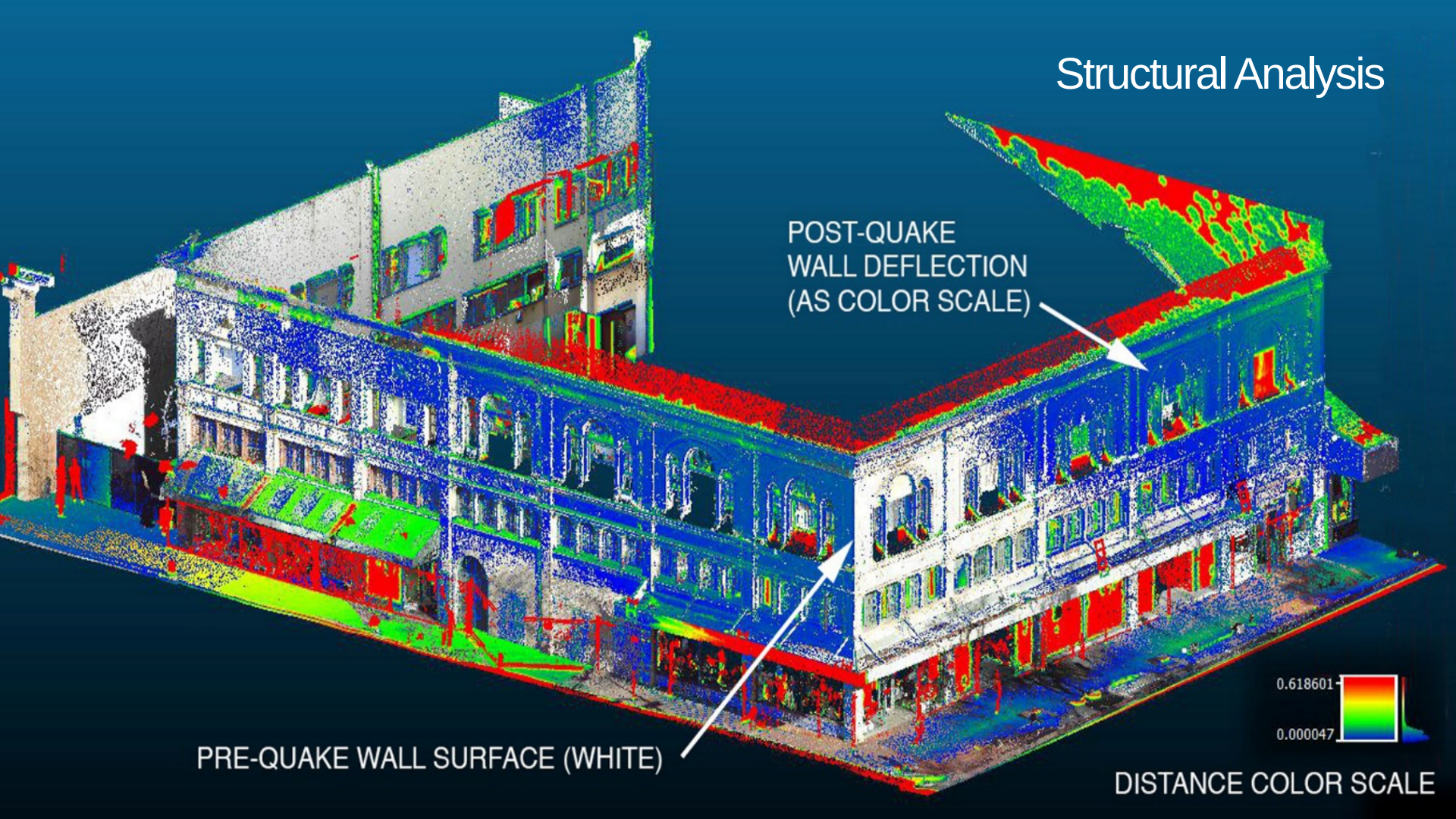


Axonometric &
Plan View

Pre-Earthquake

Post-Earthquake

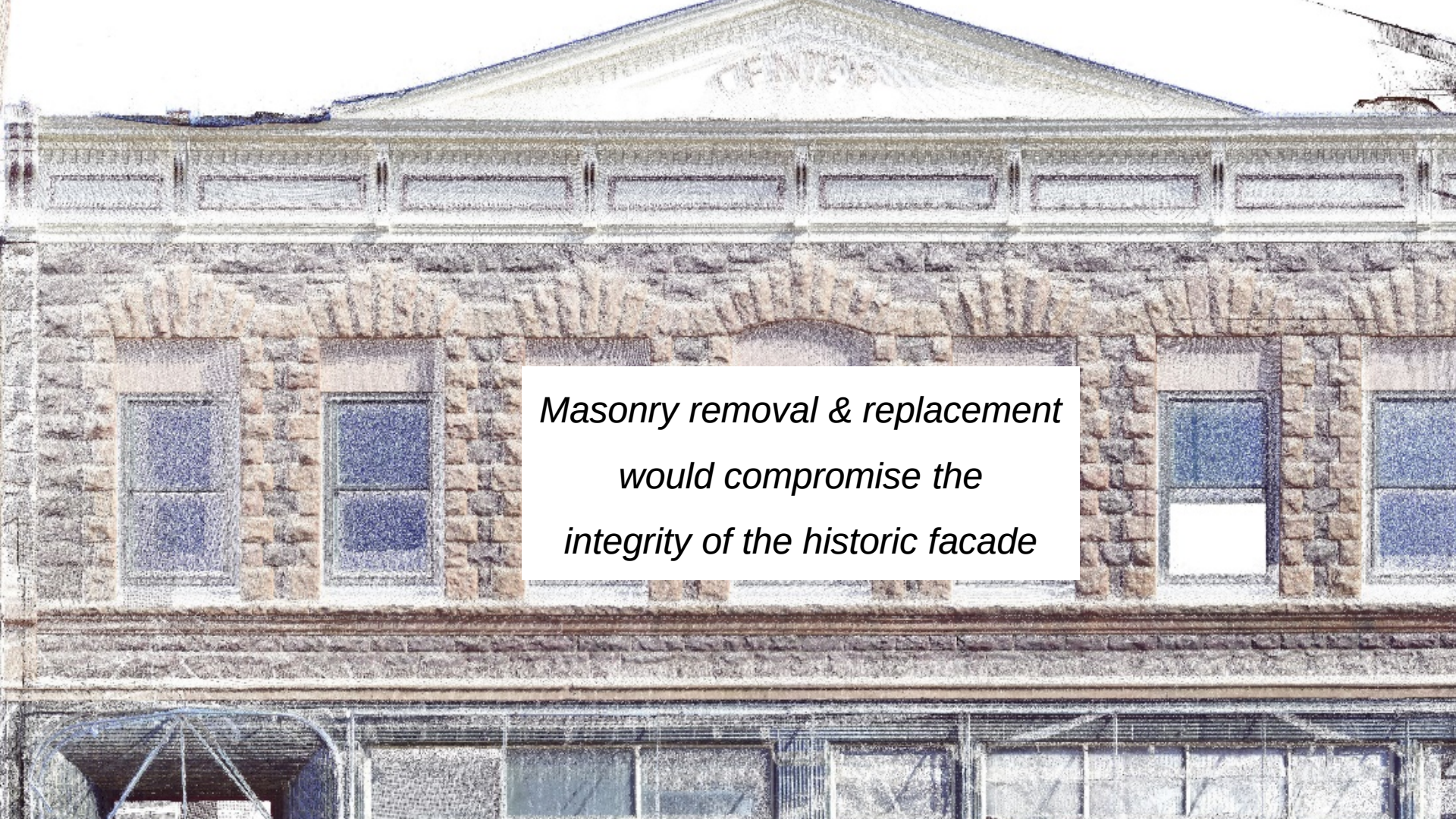
Structural Analysis



Local Landmark – Center Building, Napa, CA

Before

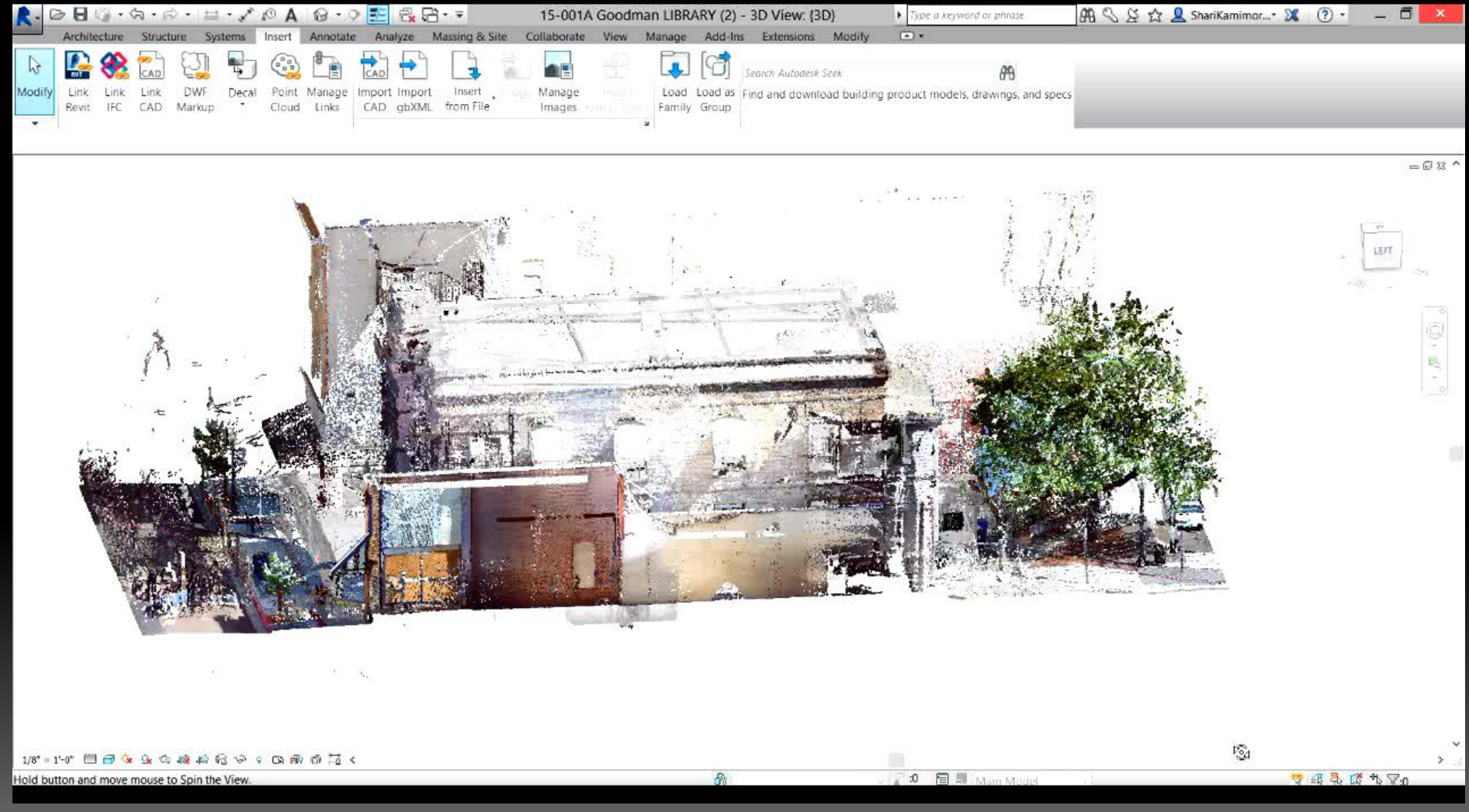

After
At risk of demolition


Masonry removal & replacement
would compromise the
integrity of the historic facade

2D CAD masonry layout
&
stone mapping

National Landmark - Goodman Library, Napa, CA

Laser scanning is an effective, non-invasive method to capture a building too fragile or structurally unsound for direct contact.


15-001A Goodman LIBRARY (2) - 3D View: {3D}
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ShariKamimor...
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
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Modify
Modify
Link Revit
Link IFC
Link CAD
DWF Markup
Decal
Point Cloud
Manage Links
Import CAD
Import gbXML
Insert from File
Manage Images
Load Family
Load as Group
Search Autodesk Seek
Find and download building product models, drawings, and specs
LEFT
1/8" = 1'-0"
Hold button and move mouse to Spin the View.
Main Model

Conclusion

Combining TLS & IRT for NDT/NDE to:

- improve knowledge of the conservation state of historic buildings;
- expand methodologies for assessment of historic building conditions;
- monitor the effects on historic buildings due to decay and natural disasters, such as earthquakes;
- provide quick data acquisition for immediate analysis with significant results.

3D LASER SCANNING TECHNOLOGY

Key in Preserving Historic Structures After South Napa Earthquake

Figure 1: 3D point cloud overlaying the 3D BIM model.

Objectives

- Present alternative preservation strategies for post-disaster public safety recovery and reconstruction methods.
- Educate city officials and disaster service workers with the Office of Emergency Services about the value of using 3D laser scanning technology to set priorities for shoring up and stabilizing buildings that present "imminent hazards."
- Serve as a model for other communities in demonstrating the effectiveness of immediate response to a seismic disaster using 3D laser scanning technology.

BY SHARI KAMIMORI

Background

Many San Francisco Bay Area residents were rudely awakened at 3.20 a.m. on August 24, 2014, by an earthquake in south Napa, Calif.—one with a magnitude of 6.0, according to the U.S. Geological Survey. It was the largest earthquake to strike the Bay Area since 1989, when the region was shaken by the unforgettable and destructive 6.9 Loma Prieta earthquake.

The epicenter was located about five miles southwest of Napa (a city of about 77,000 people) reported the Pacific Earthquake Engineering Research Center,[1] University of California at Berkeley. Although Napa received the brunt of the tremor, other nearby cities including American Canyon, Vallejo and Sonoma felt the impact. Located on the northern shores of San Francisco Bay, the Napa region is internationally known for its burgeoning wine and tourist industries.

The south Napa earthquake caused significant ground-shaking damage in the epicentral region, initially yellow tagging (restricted use) approximately 1,700 buildings in the City of Napa alone, while 200 received red tags (unsafe to enter or occupy). Of these

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