

When Can a Historic Masonry Monument Be Left Without Repair?

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National Cathedral in D.C.

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Notre-Dame Cathedral in Paris

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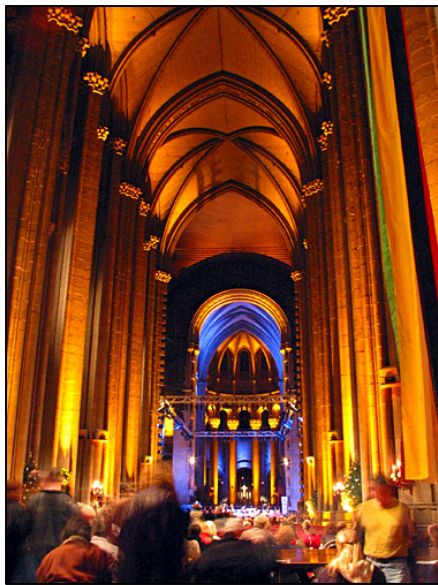
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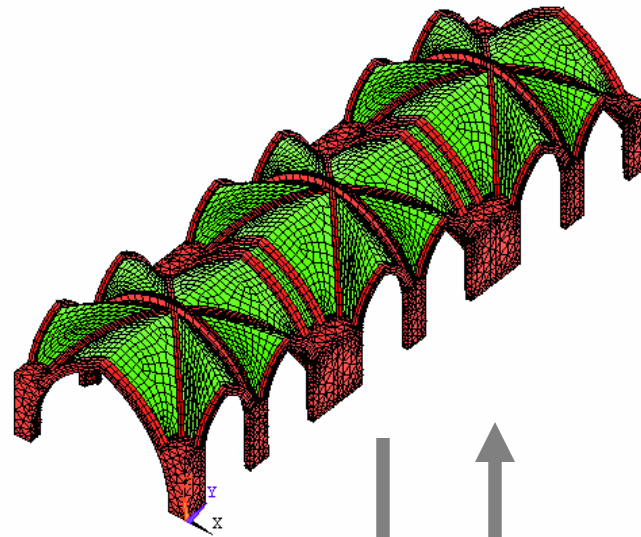
Coliseum in Rome

This talk shows the validation of numerical models with experimental data

Importance of Research



Cathedral of Saint John
the Divine in New York



Numerical
Tools

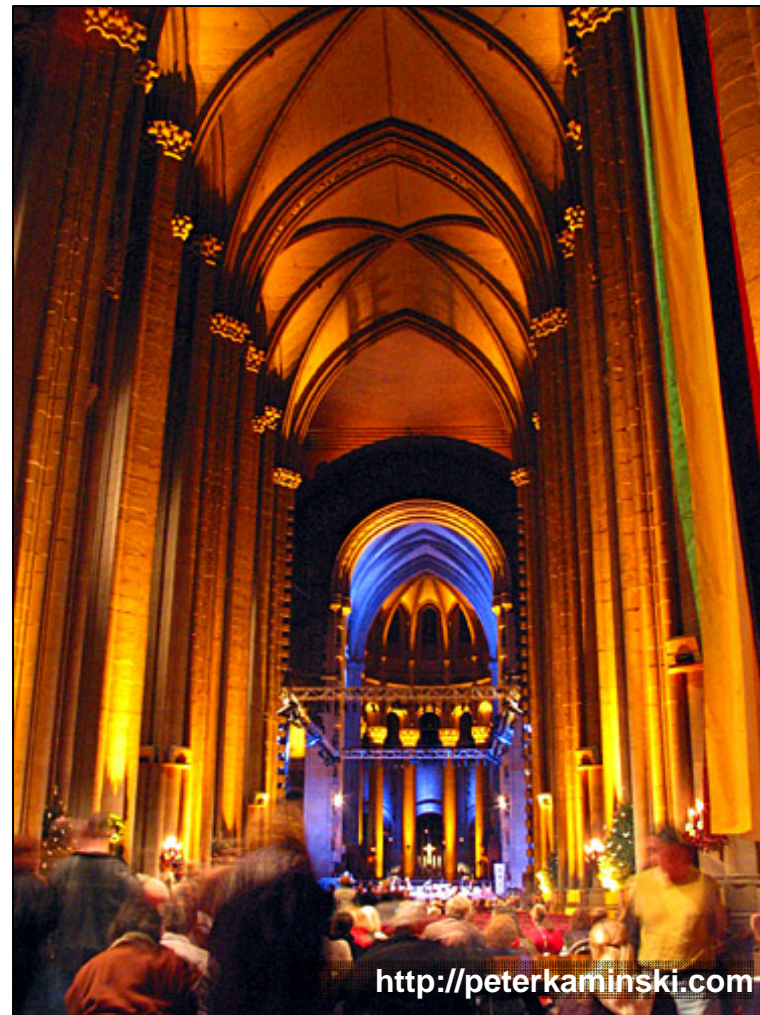


Experimental
Tools

Photo Credit: <http://peterkaminski.com>

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Condition assessment is crucial for high quality preservation practices



**Cathedral of Saint John
the Divine in New York**

Condition assessment is crucial for preservation of masonry monuments

Unmodified masonry mosque survived the 7.4 earthquake without damage (Turkey, 1999)



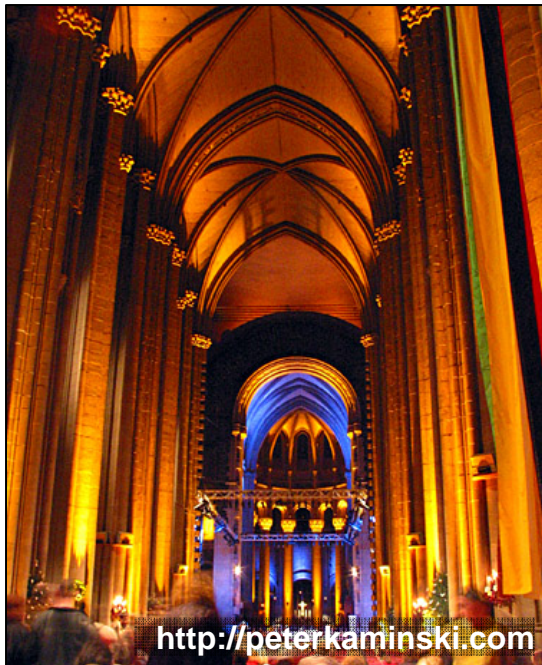
Unmodified

Modified masonry church is substantially damaged in 5.4 earthquake (Italy, 2002)



Modified

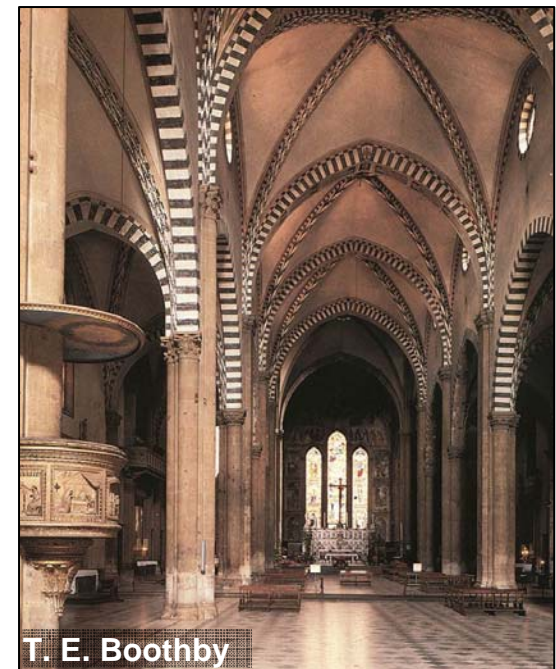
Finite element method *can* yield accurate solutions for historic masonry monuments



**Cathedral of Saint
John the Divine, USA**

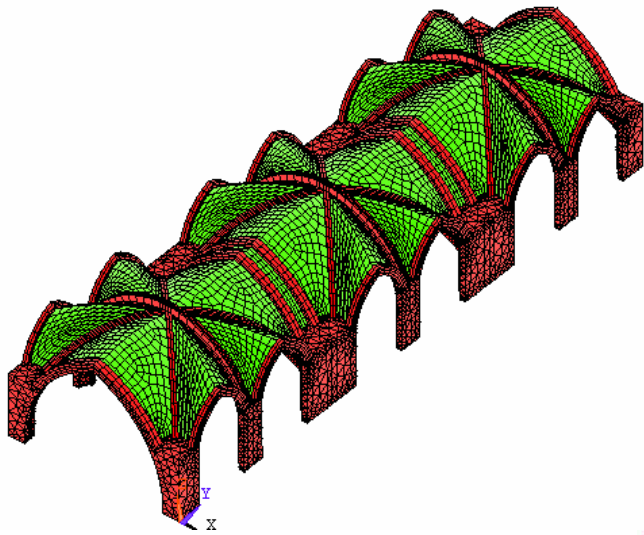


Cathedral of Crema, Italy

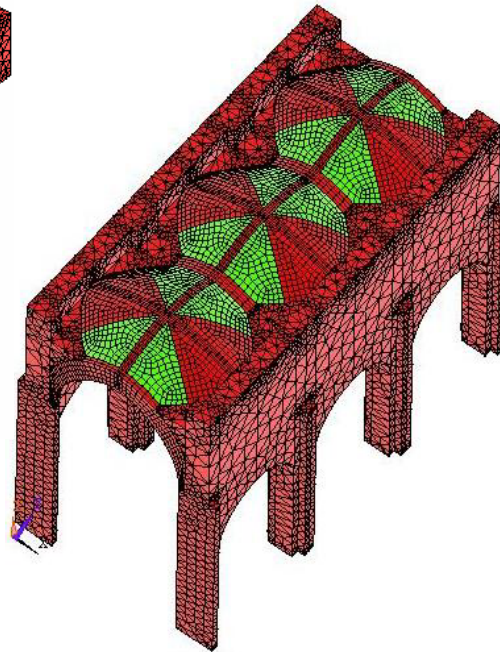


**Cathedral of Santa Maria
Novella, Italy**

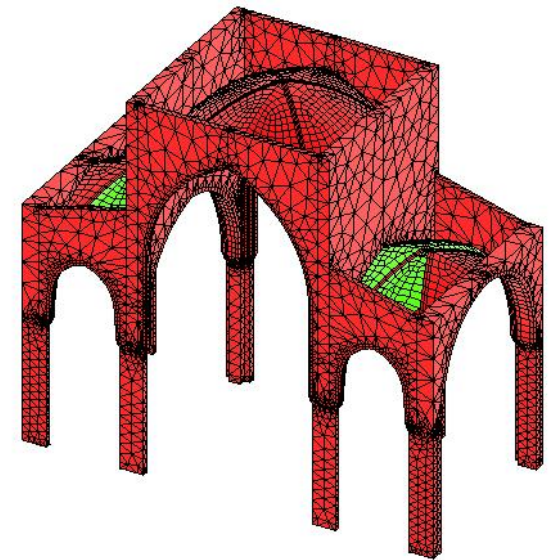
Finite element method *can* yield accurate solutions for historic masonry monuments



Cathedral of Saint
John the Divine, USA

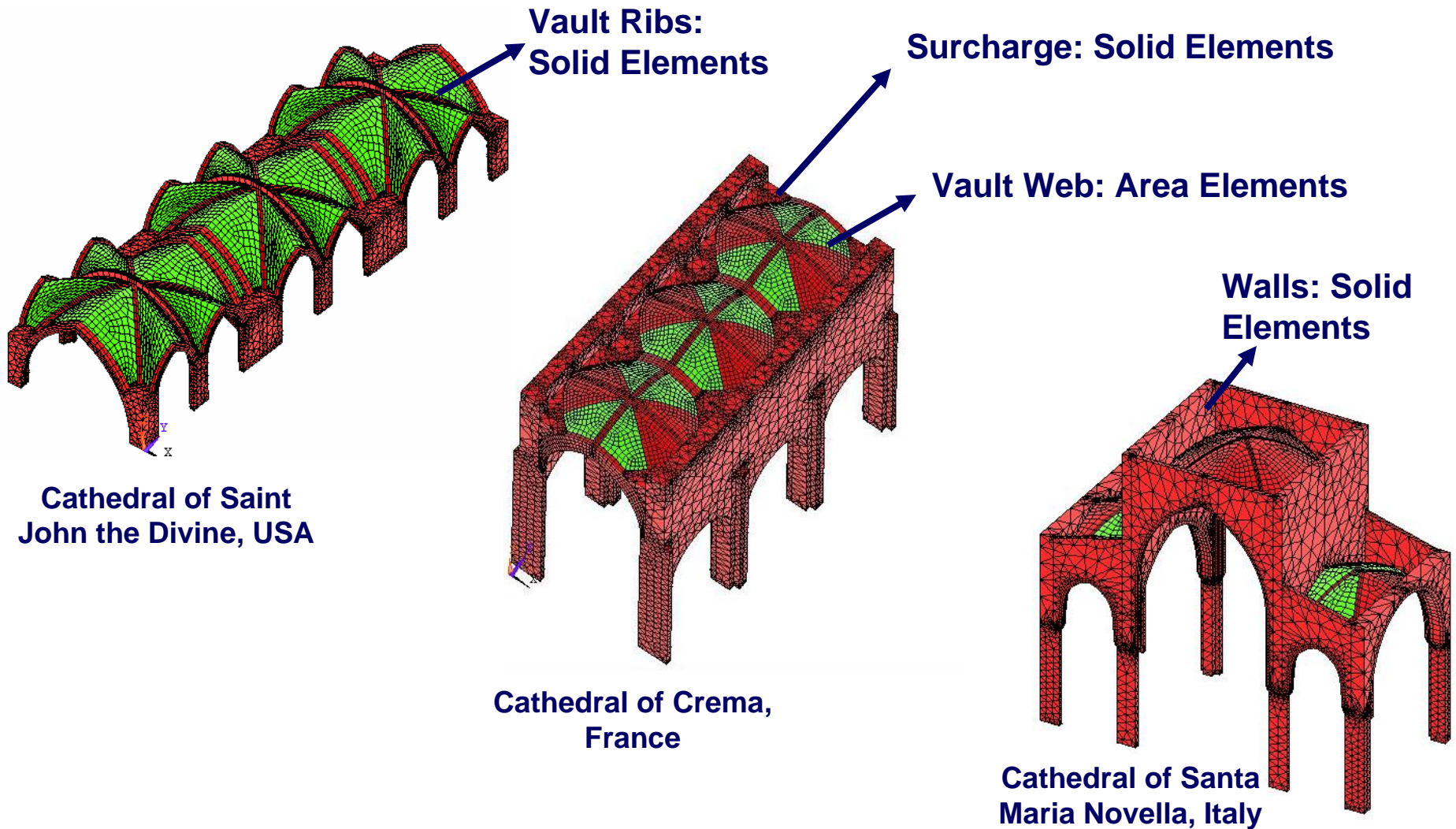


Cathedral of Crema, Italy



Cathedral of Santa
Maria Novella, Italy

Finite element method *can* yield accurate solutions for historic masonry monuments



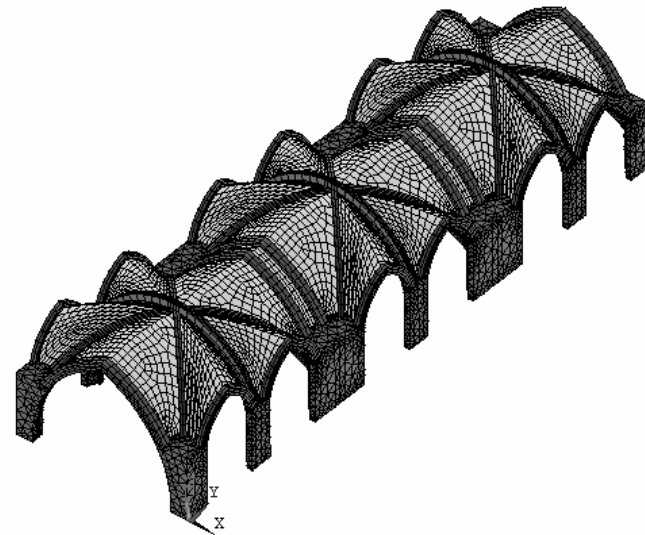
Finite element method *can* yield accurate solutions for historic masonry monuments

However, certain things have to be known:

Boundary conditions

Material properties

Damage model



Cathedral of Saint
John the Divine, USA

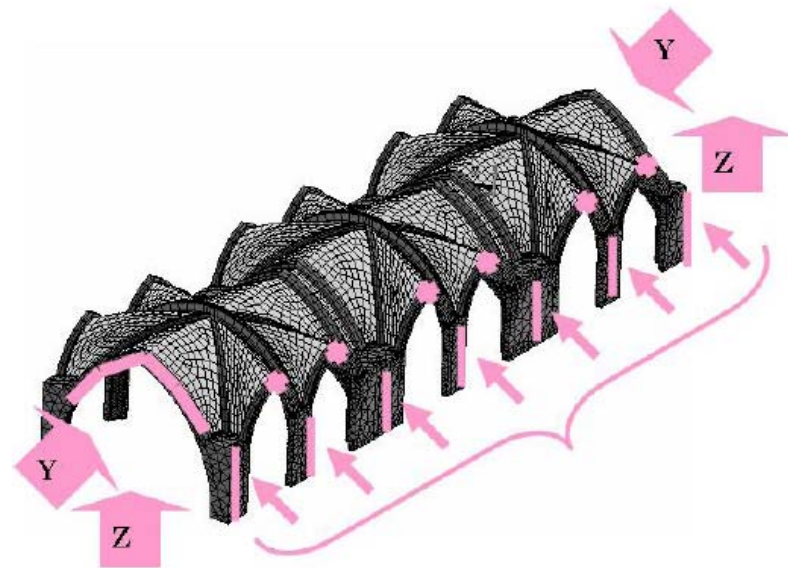
Finite element method *can* yield accurate solutions for historic masonry monuments

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Cathedral of Saint
John the Divine, USA

Experimental modal data can be used to calibrate the finite element model

**The structure can be excited by an impact hammer,
and responses collected by accelerometers**



S. Atamturktur

State Education Building, NY

The structure can be excited by an impact hammer, and responses collected by accelerometers



Experimental modal analysis techniques can be used to identify the dynamic parameters of historic masonry monuments

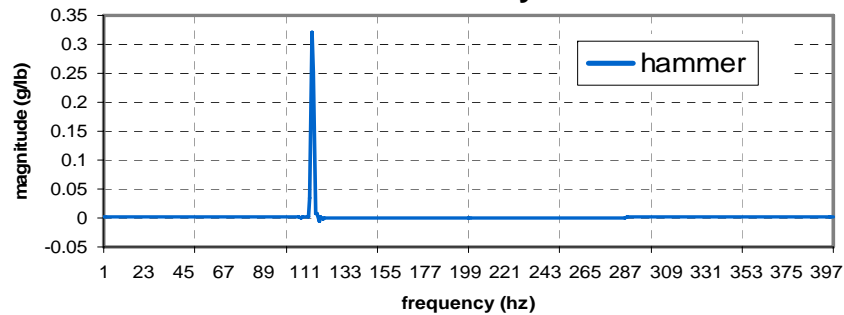
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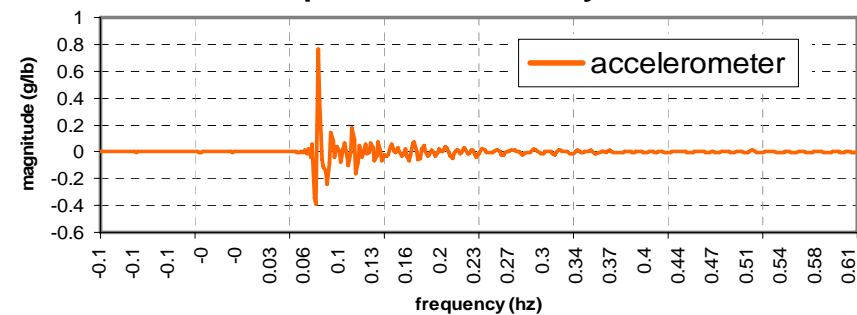
Experimental modal analysis techniques can be used to identify the dynamic parameters of historic masonry monuments

Coherent dynamic data can be acquired from the field tests on historic masonry monuments

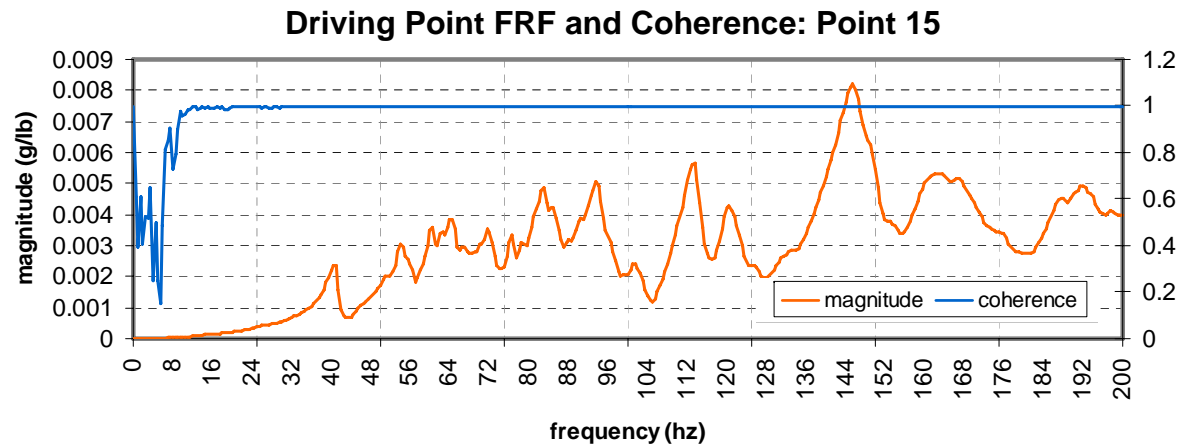
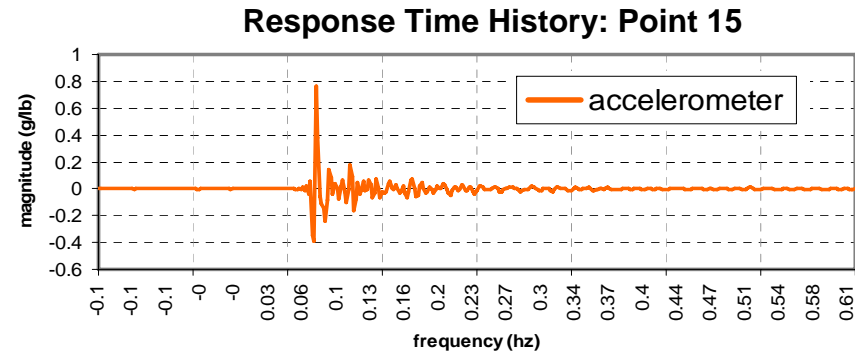
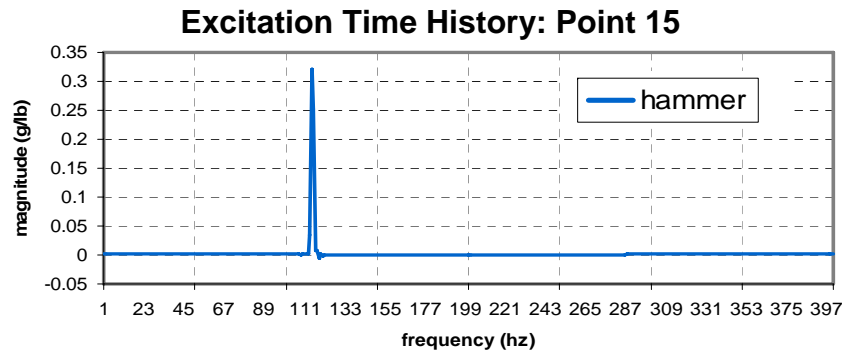
Excitation Time History: Point 15



Response Time History: Point 15



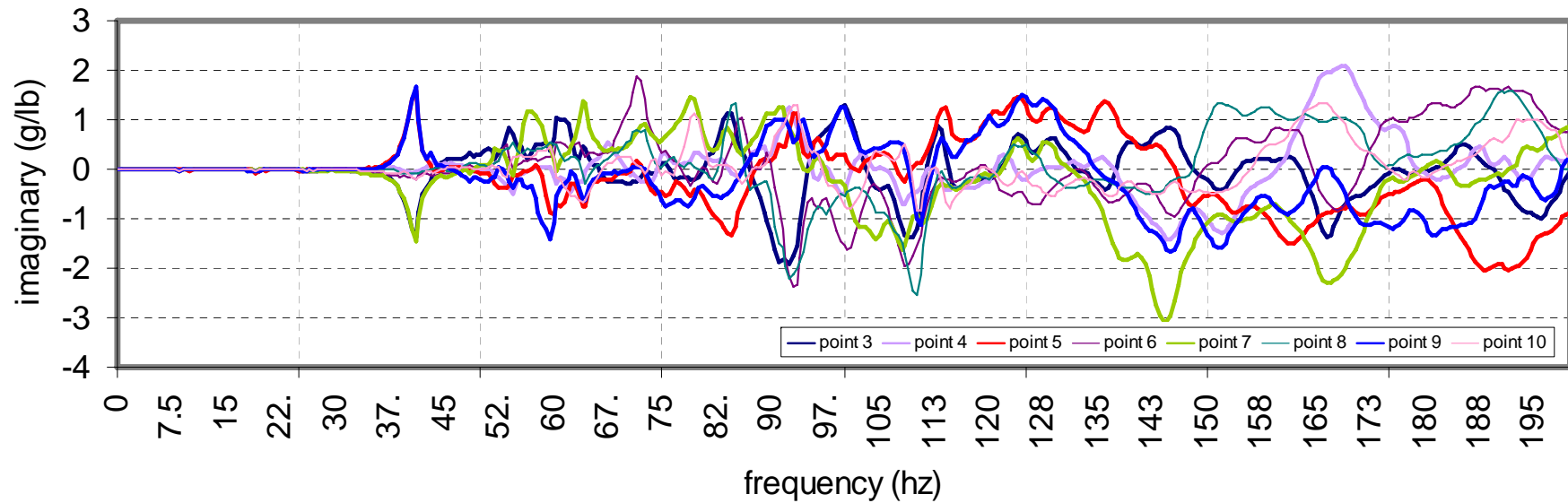
Coherent dynamic data can be acquired from the field tests on historic masonry monuments



The peaks in the Frequency Response Function reveal the linear natural frequencies of the masonry structures

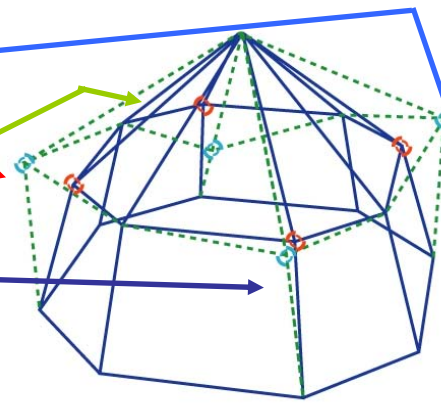
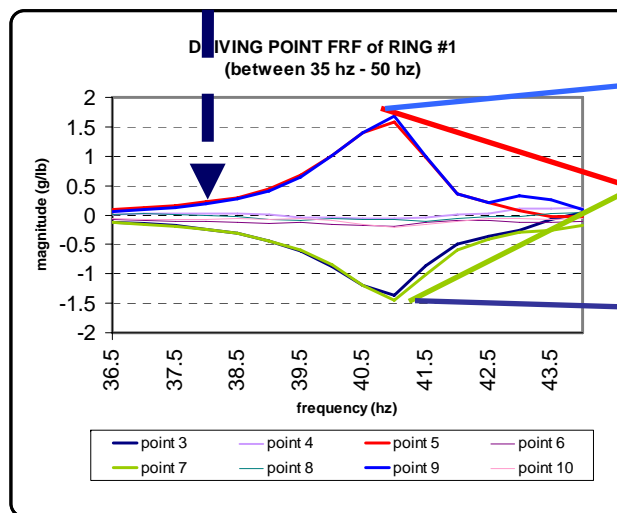
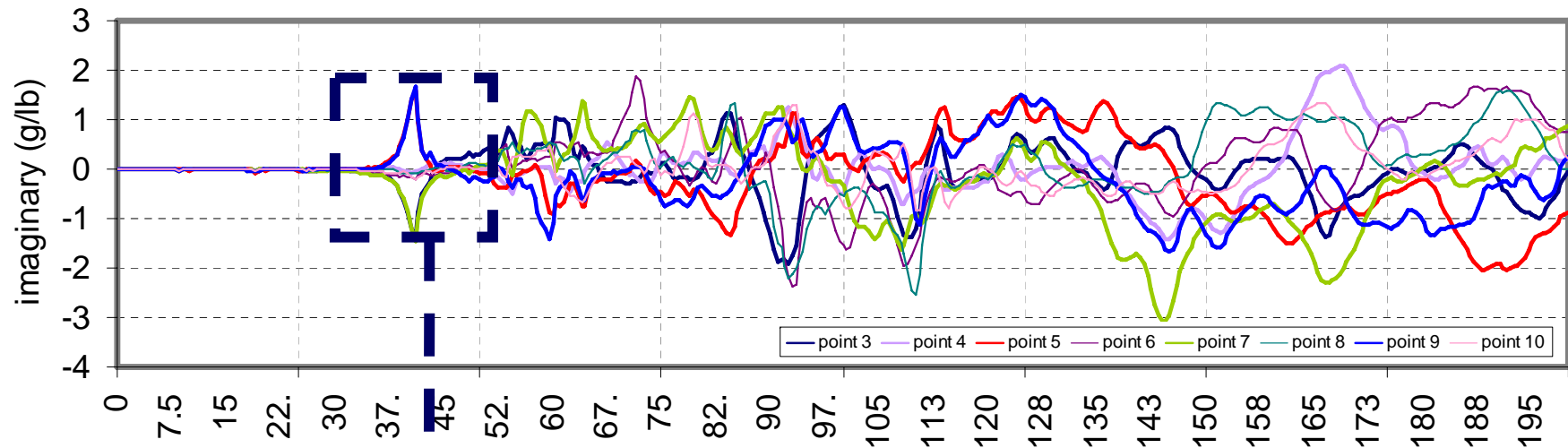
Linear mode shapes corresponding to linear natural frequencies of the structure can be identified

Driving Point FRF of Ring 1: Imaginary

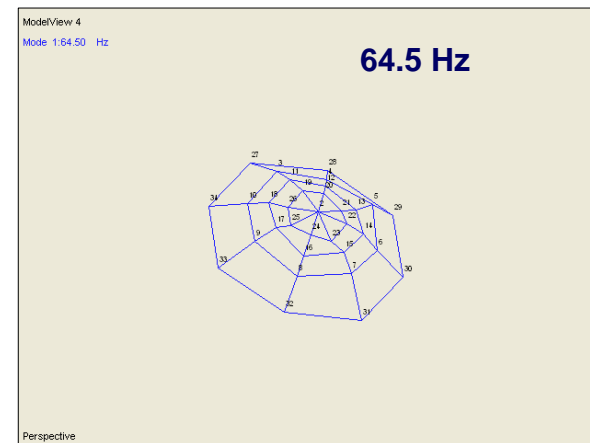
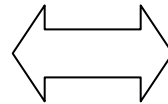
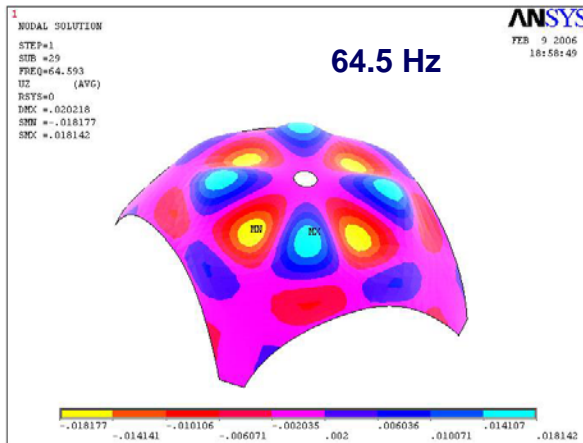
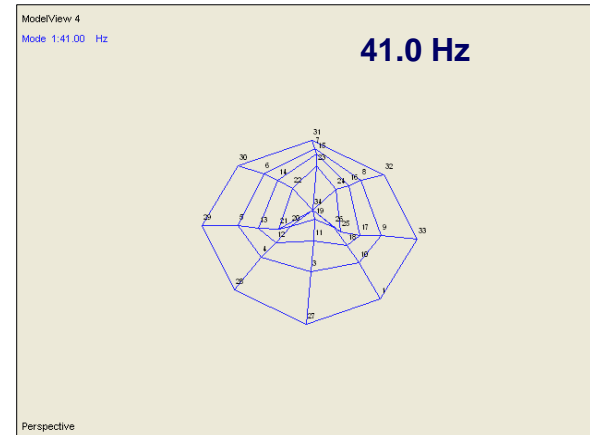
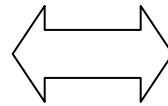
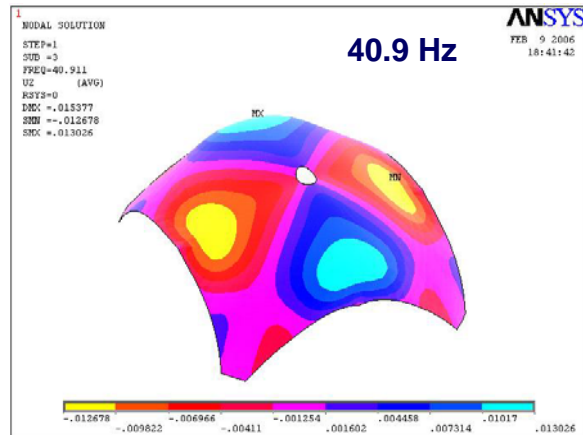


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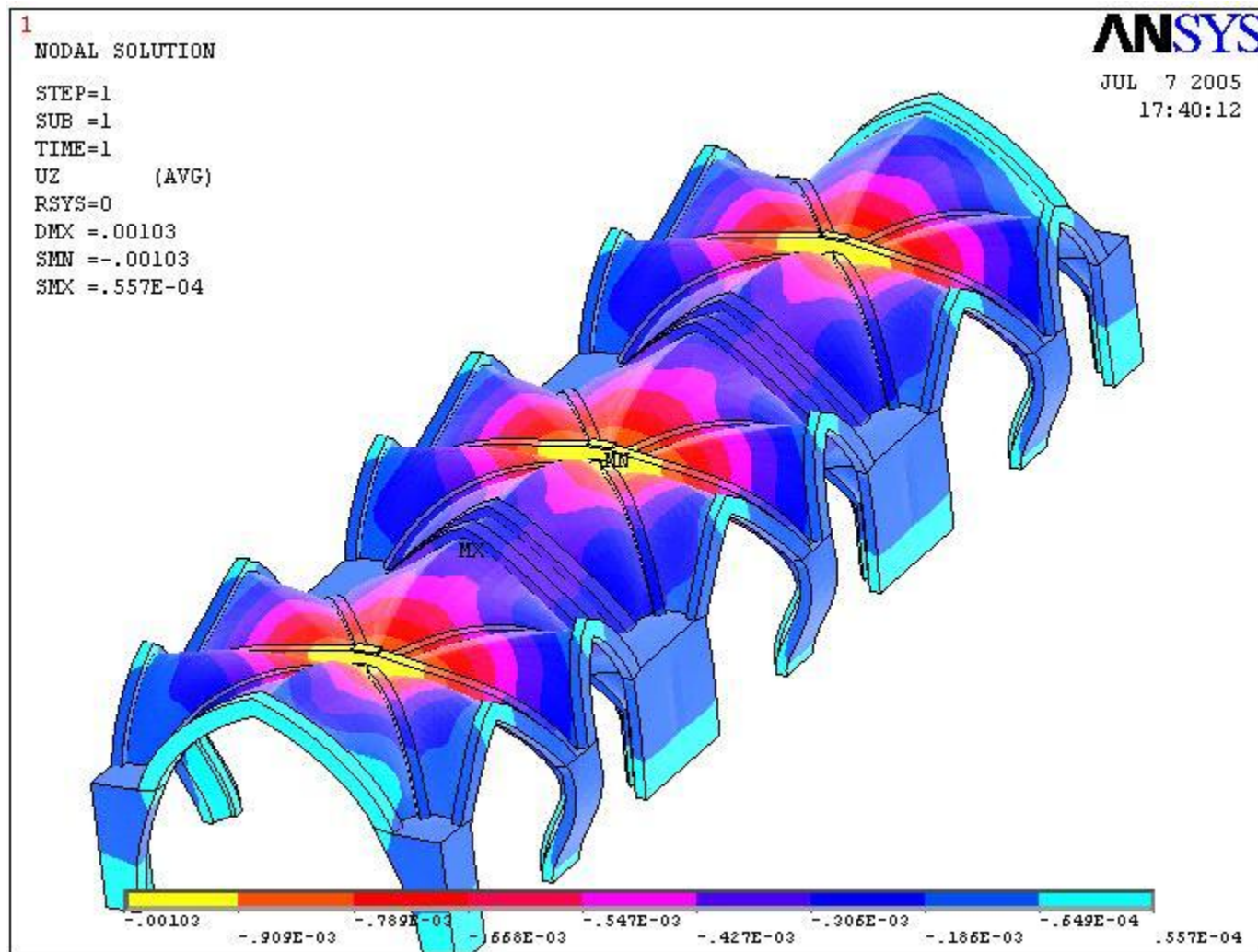


The uncertain boundary conditions, material properties, and damage model can be calibrated



The validated finite element model accurately reproduces the experimentally obtained dynamic parameters peaks

The validated numeric model can be used to assess the seismic performance of the historic monuments



In summary, developing assessment tools is crucial to preserving the heritage of masonry monuments



C.J. Langer

Questions?