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*Preliminary report on damages suffered by masonry buildings in consequence of the L'Aquila earthquake of 6<sup>th</sup> April 2009*, available on <http://www.reluis.it>



**PRELIMINARY REPORT ON DAMAGES  
SUFFERED BY MASONRY BUILDINGS  
IN CONSEQUENCE OF THE L'AQUILA  
EARTHQUAKE OF 6<sup>th</sup> APRIL 2009**



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This preliminary report shows examples of the typical damages suffered by masonry buildings during the L'Aquila earthquake.

The presented pictures represent an extract of a wider photographic documentation taken by the team of the Department of Structural Engineering (DIST) of the University of Naples Federico II, composed by Prof. Bruno Calderoni and Eng.s Emilia A. Cordasco, Costantino Giubileo and Luciano Migliaccio, went in L'Aquila and in the neighbouring in the periods 14-17 and 24-26 of April in the framework of the ReLUIs activities of evaluating the structural conditions of the buildings damaged by the main seismic event (co-ordinated by Prof. Gaetano Manfredi).

Out of plane failure mechanisms and in-plane damages to masonry walls are reported, as representation of the different structural behaviour of different masonry buildings typologies. At this aim also some not damaged buildings are reported.



**Ancient masonry of a church located in the historical centre of L'Aquila**

Out of plane behaviour: separation between two masonry walls due to poor arrangement of the stones.

*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*



**Facade of a church located in the historical centre of L'Aquila**

Out of plane behaviour: flexural mechanism of facade wall. Note the inefficient connection of the barrel vault, while iron ties avoided global overturning.

*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*



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**Building located in the historical centre of L'Aquila**

Out of plane behaviour: collapse mechanism of the upper zone of the wall. Note the poor quality of masonry, without efficient transversal connection elements, and the roof structure not well anchored to the wall. Iron ties avoided global overturning.

*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*

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**Building located in the historical centre of L'Aquila**

Out of plane behaviour: collapse of the central zone of a wall determined by the horizontal action of the wooden beam. Good connection with the roof structure and iron ties avoided global overturning.

*Photos by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*

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**Church located in the historical centre of L'Aquila**

Out of plane behaviour: overturning mechanism of the facade wall detached from orthogonal walls.

*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*





### **Church in the historical centre of Popoli (PE)**

Several iron ties, placed after Avezzano's earthquake, avoided out of the plane global failure of external walls, which resulted very damaged in their own plane. The tensile rupture of a tie testifies the strong engagement of these structural elements.

*Photos by B. Calderoni and L. Migliaccio*





**Building located in the historical centre of L'Aquila**

In plane behaviour: several iron ties, placed in correspondence of orthogonal walls at each storey, avoided the out of the plane collapse. Diagonal cracks, in both spandrels and piers, testify the engagement of the wall in its own plane.

*Photos by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*





**Building located in the historical centre of L'Aquila**

In plane behaviour: the iron ties at floor level allowed the formation of diagonal struts in the masonry spandrels.

*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*



**Building located in the historical centre of L'Aquila**

In plane behaviour: the strong engagement in compression of the diagonal strut of a pier caused out of plane instability with expulsion of some masonry parts.

*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*



**Building located in the historical centre of L'Aquila**

Good behaviour of masonry buildings in presence of ancient iron ties: Only some negligible diagonal cracks are visible on the spandrels.

*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*



**Building located in the historical centre of L'Aquila**

Good behaviour of masonry buildings in presence of ancient iron ties: No damages are visible on the external walls.

*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*





**Building located in the historical centre of L'Aquila**

Good seismic behaviour of a "modern" masonry building with r.c. floors (*"third class"* building). No out of plane behaviour is possible, while diagonal cracks in the piers testify the wall engagement in its own plane.

*Photos by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*





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**Aggregates and complex buildings in the historical centre of L'Aquila**  
In plane damages of third storey due to different heights of adjacent buildings.  
*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*



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**Aggregates and complex buildings in the historical centre of L'Aquila**  
Collapse of the upper zone of masonry walls due to the out of plane action of roof.  
*Photo by B. Calderoni, E.A. Cordasco, C. Giubileo and L. Migliaccio*