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**REPORT ON THE DAMAGES ON BUILDINGS
FOLLOWING THE SEISMIC EVENT OF 6TH OF
APRIL 2009 TIME 1.32 (UTC) – L'AQUILA M=5.8**



V1.20

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In consequence of the seismic event which hit L'Aquila city and neighboring towns on Sunday 6th of April 2009, a team from the Department of Structural Engineering (DIST) of the University of Naples Federico II, Professor Edoardo Cosenza (Dean of the Faculty of Engineering), Professor Gaetano Manfredi (President of ReLuis) and Engineers Iunio Iervolino, Andrea Prota, Paolo Ricci and Gerardo M. Verderame, went there under the supervision of Professor Mauro Dolce, from the Department of Civil Protection.

A wide photographic documentation on the principal collapses and the different failure mechanisms, both on reinforced concrete and masonry buildings, has been produced based on different surveys, carried out from Monday 7th of April 2009 up to Friday 10th of April 2009.

In the following an extract of this photographic documentation is reported.

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Masonry building located in Via XX Settembre – L’Aquila

Evidence of diagonal cracks in masonry walls at the second level of the building.

Photo by P. Ricci and G.M. Verderame

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Masonry building located in Via XX Settembre – L’Aquila

Diagonal cracks involving spandrel beams and masonry walls at the first level.

Photo by P. Ricci and G.M. Verderame

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Collapse of a reinforced concrete (R.C.) building

Construction realized in 60's in adhesion with a pre-existing building. Infill panels are made up of solid bricks, R.C. elements are reinforced with plain bars.

Photo by P. Ricci and G.M. Verderame



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Collapse of a reinforced concrete building

Detail of longitudinal plain reinforcement of the beam. The hook anchorages both of inferior and superior reinforcement are clearly shown.

Photo by P. Ricci and G.M. Verderame

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Hotel Duca degli Abruzzi – L’Aquila

Collapsed wing of the building. The remaining part, severely damaged, is strongly inclined.

Photo by P. Ricci and G.M. Verderame

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Casa dello Studente – L’Aquila

Image of the collapsed portion of the building. The failure mechanism involved all of the stories; beams show a high plastic rotation.

Photo by I. Iervolino



Casa dello Studente – L’Aquila

Detail of the plastic rotation of floor slab (beams).

Photo by I. Iervolino



Soft storey mechanism on a three stories R.C. building – Pettino (AQ)

First storey is characterized by wide openings (entrance and garages) unlike the remaining ones; the displacement demand has been concentrated at the ground level.

Photo by P. Ricci and G.M. Verderame



Soft storey mechanism on a three stories R.C. building – Pettino (AQ)

First level columns damage. First and third columns seem to be completely apart from the structure, second one has kept its original position unless a foundation settlement.

Photo by P. Ricci and G.M. Verderame



Soft storey mechanism on a three stories R.C. building – Pettino (AQ)

Detail of the corner column. It is worth to note stirrups absence in the beam-column joint.

Photo by P. Ricci and G.M. Verderame



Soft storey mechanism on a four stories R.C. building – Pettino (AQ)

As well as the previous case the first storey shows large openings: displacement demand is concentrated at the ground level.

Photo by P. Ricci and G.M. Verderame



Infills damage: four stories R.C. building

Evidence of typical diagonal cracks at the first two levels.

Photo by P. Ricci and G.M. Verderame



Infills damage: four stories R.C. building
External infills ejecting at the second and third levels.
Photo by P. Ricci and G.M. Verderame



Infills damage
Double clay block infill. External infill ejecting, ruined on cars beneath.
Photo by P. Ricci and G.M. Verderame



Infills damage

Internal infill is made up of clay blocks, external one of solid bricks.

Photo by P. Ricci and G.M. Verderame



Infills damage

Clay blocks connection between internal infill and external one. Upper bound of the external infill is encased in the beam through a tooth jutting out of the R.C. beam.

Photo by P. Ricci and G.M. Verderame



Infills damage close to windows openings

Connection between the two infills is made up of single clay blocks or solid bricks placed 50-60 cm from one another.
Photo by P. Ricci and G.M. Verderame



Reinforced concrete building placed in Via XX Settembre – L'Aquila

Building is characterized by pronounced plan irregularity. It is worth to underline the complete infill ejecting at the ground floor and the internal infills damaging. Marble coverings and shop glazes at the ground level do not show any damage.

Photo by I. Iervolino



Reinforced concrete building placed in Via XX Settembre – L'Aquila
Total and partial ejecting of corner infills at first level.
Photo by I. Iervolino



Infills damage
Partial ejecting of external infill, made up of solid bricks. The separation joint, large about 2 cm, and collapse of clay blocks flue are clearly shown.
Photo by I. Iervolino



External joint damage

Diagonal cracking highlights a shear failure of the external joint. Buckling of longitudinal bar highlights total absence of stirrups in the joint and along the first 20-30 cm of upper end of column.

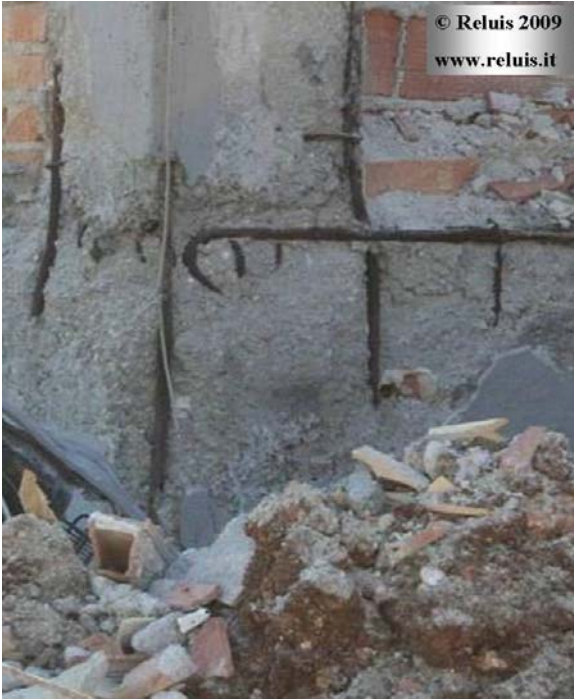
Photo by P. Ricci and G.M. Verderame



External joint damage

Stirrups absence in joint involves buckling of longitudinal bars in column; concrete cover spalling is due to the anchorage of longitudinal bars in orthogonal beam.

Photo by P. Ricci and G.M. Verderame



External joint damage

Reinforcing bars are plain, concrete shows scarce quality. Hook anchorage of beam longitudinal bars, absence of stirrups in joint and stirrup spacing in columns are evident.

Photo by *P. Ricci and G.M. Verderame*



Column damage

Upper end failure of column highlights scarce concrete quality and poor transversal reinforcement.

Photo by *P. Ricci and G.M. Verderame*



Column damage

Upper end failure of the column clearly underlines the casting separation between beam and column. Stirrups absence along first 20-30 cm of column is clearly showed again.

Photo by P. Ricci and G.M. Verderame



Column damage

Overlapping detail of longitudinal reinforcement in the column. Plain reinforcing bars are anchored with end hooks. Stirrups absence along first 30-40 cm of column is showed.

Photo by P. Ricci and G.M. Verderame



Column damage

Shear failure of upper column end. Longitudinal bars are buckled and transversal reinforcement is poor.

Photo by P. Ricci and G.M. Verderame



Column damage

Diagonal failure of upper column end involving part of beam-column joint. Two longitudinal bars in column are buckled and stirrups are absent along first 20 cm of the column.

Photo by P. Ricci and G.M. Verderame



Stairs damage
Shear failure of a short column in the staircase.
Photo by G. De Carlo and G.M. Verderame



Stairs damage
Wide crack between stair slab and last step.
Photo by P. Ricci and G.M. Verderame

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Residential building at Porta Napoli

Up and right (from Google StreetView): the building before the quake. Down: The soft floor between 2nd and 4th level has collapsed, due to the failure of the RC columns (pilotis), whose reinforcement, both rebars and stirrups, is clearly visible in the detail.

Photos by A. Occhiuzzi, N. Caterino and G. Maddaloni