How science supports national preparedness: Earthquake Engineering

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Rome, 09-10 March 2017
ORDINANCE OF THE PRIME MINISTER
3274/2003

ART. 4

1. Al fine di assicurare la più agevole ed uniforme applicazione delle disposizioni di cui alla presente ordinanza, il Dipartimento della protezione civile è autorizzato a promuovere la costituzione di un centro di formazione e ricerca nel campo dell’ingegneria sismica e di una rete dei laboratori universitari operanti nel medesimo settore.

Competence Centres

REte dei Laboratori Universitari di Ingegneria Sismica
Charter members: Univ. Basilicata, Napoli, Pavia and Univ. di Trento) Collaboration with ENEA

Network of University Laboratories in Earthquake Engineering
What is ReLUIS?

The consortium ReLUIS has many similarities with other earthquake engineering networks (i.e. Network for Earthquake Engineering Simulation – NEES and Asian Pacific Network for Center of Engineering Research - ANCER).

ReLUIS, is an interuniversity consortium with the purpose to coordinate the University Laboratories activity of seismic engineering, giving scientific, organizational, technical and financial supports to associated University Laboratories.
EUROPEAN CENTRE FOR TRAINING AND RESEARCH IN EARTHQUAKE ENGINEERING

Prepareness activities

Territorial Management system for real time scenarios

2. Mobile Lab and System for ordinary & advanced structural assessment

Simplified modelling

3. temporary accommodation management support system

Cloud updating

structure survey

testing
Some activities carried out in the aftermath of earthquakes
ReLUIS – School Buildings in situ inspections 2009-2016

**L’AQUILA 2009**
- 324 school buildings – province of L’Aquila
- (480 school buildings)
- **296 SCHOOLS**

**EMILIA 2012**
- 200 school buildings

**Central Italy (Aug. 24 2016)**
- 253 school buildings in 4 Regions
- **160 SCHOOLS**

**Central Italy (Oct. 26-30 2016)**
- 122 school buildings Marche and Abruzzo

MORE THAN 1000 IN SITU INSPECTIONS
ReLUIS – School Buildings in situ inspections 2009-2016
ReLUUIS support for local strengthening interventions

- 35 schools in l’Aquila, 20.7 MI
- 25 schools in other municipalities, 8.3 MI
- 3 schools closed after material tests
After 6 months we even want to come back to school, ALL OF US!!!

Best wishes for the new year at school!!
ReLUUIS support for local strengthening interventions

Beam column joints

Infill connections
No requests of in situ inspections for these schools after 2016 central Italy earthquake = no damage
ReLUI - School Buildings

Central Italy 2016

(01.36 a.m. 24 Agosto 2016)

Damage level vs. PGA

Peak Ground Acceleration [g]

% corpi di fabbrica

N. 253 corpi di fabbrica

Esito di agibilità [-]

ReLUI - N. 253 corpi di fabbrica

Map Version: 17 Processed 2016-05-07 10:00:15 UTC

PERCEIVED DAMAGE
Natl feel
Weak
Light
Moderate
Strong
Very strong
Severe
Violent
Extreme

INSTRUMENTAL INTENSITY
I
II-III
IV
V
VI
VII
VIII
IX
X+

PEAK ACC (m/s²)
<0.06
0.06-0.10
0.10-0.15
0.15-0.20
0.20-0.25
0.25-0.30
>0.30
ReL UIS - School Buildings

Central Italy 2016

NORCIA, PERUGIA (06.40 a.m. 30 Ottobre 2016)

Damage level vs. PGA

ReL UIS - N. 93 buildings

Peak Ground Acceleration [g]

% of buildings

N. of buildings

Map Version 25 Processed 2016-11-09 08:20:54 UTC

IN GV ShakeMap: Magnitude 6.5

Shaking: Weak Strong Severe

PERUGIA

TERAMO

MACERATA

ASCOLI PICENO

TERNI

RIETI

CHIETI

Scale based upon Fianza and Michelini, 2016, 2011
Central Italy – In situ inspections on Cultural Heritage

• In situ inspections to assess usability and damage of cultural heritage, particularly Churches, Palaces, Bell Towers and similar

• Activity under coordination of Department of Civil Protection and Ministry of Cultural Heritage

• between September 13 and October 26, 953 inspections (225 Marche, 326 Abruzzo, 107 Lazio, 295 Umbria)

• between November 15 and January 18, 516 inspections (134 Marche, 61 Abruzzo, 47 Lazio, 274 Umbria)

• since January 23 up to March 7, 2,969 inspections

• total 4,438, activity still ongoing

• about 100 man months (inspections, coordination, monitoring of data)
DESIGNA: temporary accommodation management support system

Web-based management system to support the real-time coordination and management of accommodation needs for evacuated people.
Eucentre

Central Italy EQ - Technical Reconnaissance Activities

jointly with high level partners

webpage within several days of the briefing.

2016 Central Italy Earthquake Lessons from the Field

Event sponsored by:

EERI reconnaissance

AFPS dams reconnaissance

2 GEER geotechnical reconnaissance
Some activities carried out to support reconstruction process
The approval process of funding requests

- **The “Filiera” activity (L’Aquila)**

  The process consists of a series of checks by:

  1. **FINTECNA**: Finanziaria per i Settori Industriale e dei Servizi S.p.A.

      FINTECNA - Ministry of Economy and Finance, evaluates **administrative check** of application and documentation.

  2. **ReLUIS**: Laboratories University Network of seismic engineering

      Compliance between: i) repair intervention and damages; ii) local strengthening interventions and **Italian seismic code provisions** (NTC 08 and Circ. 617/2009 as well as specific provisions for the Abruzzo Emergency (O.P.C.M. 3779, 3790 and Annexes by DPC). **Technical check**

  3. **CINEAS**: Interuniversity Consortium of Insurance Engineering

      **Financial check**
The approval process of funding requests

• **The “Filiera” activity**

**WHITE BOOK ON THE RECONSTRUCTION OF PRIVATE BUILDINGS DAMAGED BY THE L’AQUILA EARTHQUAKE**

Free download from www.reluis.it
Light reconstruction - Approval process

**Funding requests grant (B or C buildings)**

<table>
<thead>
<tr>
<th>Date</th>
<th>n° requests approved</th>
<th>Grant</th>
</tr>
</thead>
<tbody>
<tr>
<td>[-]</td>
<td>[-]</td>
<td>[€]</td>
</tr>
<tr>
<td>December 2009</td>
<td>34</td>
<td>940.492,17</td>
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<tr>
<td>March 2010</td>
<td>5.957</td>
<td>246.860.149,31</td>
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<tr>
<td><strong>September 2010</strong></td>
<td>8.467</td>
<td><strong>534.359.872,31</strong></td>
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<td>September 2011</td>
<td>9.048</td>
<td>509.215.730,00</td>
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<tr>
<td>March 2013</td>
<td>9.247</td>
<td>532.259.802,10</td>
</tr>
<tr>
<td>September 2013</td>
<td>9.281</td>
<td>534.359.872,31</td>
</tr>
</tbody>
</table>

After 1 year 90% (8467 of 10439) financially approved by the municipality

✅ **Municipalities grant released:** A grant of about 452 million of euro at September 2010, total “ligth” reconstruction costs of about € 534.000.000, 00
Light reconstruction – Costs

- **Costs on 2501 Private buildings – L’Aquila Buildings B or C:**

  The grant includes the costs for **repair intervention** + **local strengthening** of structural or no-structural members.

  - 1.599 R.C. buildings - mean grant: 246 €/m$^2$

  - 902 masonry buildings mean grant: 318 €/m$^2$

Costs include: practitioners technical fees and V.A.T.
• **Funding requests submission (E buildings)**

<table>
<thead>
<tr>
<th>Date</th>
<th>n° approval funding request</th>
<th>Grant</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 2010</td>
<td>10</td>
<td>2.520.526,28</td>
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<td>September 2010</td>
<td>172</td>
<td>16.189.933,57</td>
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<td>September 2011</td>
<td>1.325</td>
<td>231.255.611,15</td>
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<td>September 2012</td>
<td>4.595</td>
<td>901.860.304,41</td>
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<td>September 2013</td>
<td>6.257</td>
<td>1.604.415.532,45</td>
</tr>
</tbody>
</table>

After 3 years, 50% of requests (4585 out of 8906) financially approved by the municipalities

✓ **Municipalities grant released:** A grant of about 900 million of euro at September 2012, total “heavy” reconstruction costs of about € 1,600,000,000, 00
Costs on 762 Private building – L’Aquila

Buildings E:
The grant includes the costs for repair intervention + seismic strengthening, + energy efficiency upgrade + structural and geotechnical tests.

- **448 R.C. buildings - mean grant: 1030 €/m²**
  (about 4 times higher than in case of B or C buildings – 246 €/mq)

- **314 masonry buildings mean grant: 935 €/m²**
  (about 3 times higher than in case of B or C buildings – 318 €/mq)

Costs include:
practitioners technical fees and V.A.T.
Details can be found in:

Reconstruction process of damaged residential buildings outside historical centres after the L’Aquila earthquake: part I—“light damage” reconstruction

Marco Di Ludovico¹ · Andrea Prota¹ · Claudio Moroni² · Gaetano Manfredi¹ · Mauro Dolce²

Reconstruction process of damaged residential buildings outside historical centres after the L’Aquila earthquake: part II—“heavy damage” reconstruction

Marco Di Ludovico¹ · Andrea Prota¹ · Claudio Moroni² · Gaetano Manfredi¹ · Mauro Dolce²
Central Italy 2016 – Severely damaged schools

- Activity carried out between December 3, 2016 and January 8, 2017
- Objective: to support decision makers (owners of schools) for the selection of 1 of these 2 options: repair and upgrade existing schools; build a new school in other site and no investment of existing school
- Methodology: determine damage level on the basis of Aedes form + additional detailed in situ inspection; determine vulnerability based on available technical material collected from owner + qualitative assessment based on experience and/or simplified analyses
- Total of 68 schools, 84 analyzed school buildings
- 18 involved Research Units
- 98 involved Researchers
Some activities carried out to increase preparedness and resilience
Initiative to improve community resilience

Public information on risk

TERREMOTO PARLIAMONE INSIEME
Earthquake: let's talk together

Immediately after Emilia Earthquake

Series of events, started on 11 June 2012, sponsored by the Civil Protection Department, Emilia-Romagna Region and the National Institute of Geophysics and Vulcanology in collaboration with the Network of University Laboratories for Earthquake Engineering, the Regional Health Service of Emilia Romagna and voluntary organizations of civil protection

- 32 meetings on the Italian territory
Robustness and resilience – ReLUIIS – DPC projects

Initiative for seismic risk reduction

Public information on risk

TERREMOTO IO NON RISCHIO “Earthquake I don’t risk”

102 squares in 100 Municipalities in 2012

215 squares in 200 Municipalities in 2013

223 squares in 203 Municipalities in 2014

400 squares in 2015; 650 squares in 2016

www.iononrischio.it
Research, dissemination and technology transfer
Territorial Risk Management SYSTEM

WebGIS for the computation of seismic risk maps and real time damage scenarios.

- Residential buildings (ISTAT 2001)
- Road way network (17,000 bridges, 38 airports)
- 50,000 schools
- 32 harbors
- 238 dams
Macro-module for post-earthquake building safety assessment and countermeasures

1. structure survey

2. testing

3. Simplified modelling & evaluation

4. Cloud updating

On Site Structural Assessment module Operational scheme
ReLUUIS – Guidelines and software

Linee guida per
Riparazione e rafforzamento
di elementi strutturali,
tamponature e partizioni

Linee guida per
Modalità di indagine
sulle strutture e sui terreni
per i progetti di riparazione,
miglioramento e ricostruzione
di edifici inagibili

www.reluis.it
ReLUIS – Guidelines and software

www.reluis.it
ReLUIS – Research on topical issues: out-of-plane failure
ReLUUIS – Research on topical issues: out-of-plane failure

Progetto DPC/ReLUUIS 2014-2016

Progetto speciale RS 5 – Opere Provisionsalii

In collaborazione con:
STCS-CNVI: Short-Term Countermeasures System
Corpo Nazionale dei Vigili del Fuoco

Maggio 2016