RECONSTRUCTION PLANS: CASE STUDIES IN ITALY

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INGEGNERIA CIVILE, EDILE E AMBIENTALE CIVIL, ARCHITECTURAL AND ENVIRONMENTAL ENGINEERING



Seismic Risk Preparedness and Mitigation of Culture Heritage Sites מוכנות והיערכות לסיכוני רעידות אדמה באתרי מורשת תרבות

Israel, Jerusalem. 19-20 January 2014 ירושלים. יח'-יט' בשבט, תשע״ד

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 - Villa Santa Lucia degli Abruzzi
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1. INTRODUCTION: the earthquake of April 6th 2009 in Abruzzo



On the 6th of April 2009 a major earthquake struck the central part of Italy. The historical city of L'Aquila was dramatically damaged such as several small towns in the same area.



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1. INTRODUCTION: the earthquake of April 6th 2009 in Abruzzo



Seismic sequence updated to Sep 24, 2009

MI 5.8

Mw 6.3







Map of active faults around L'Aquila



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2. THE RECONSTRUCTION PLANS

The Reconstruction Plans:

- 1. guarantee the socio-economic upswing of the territory,
- 2. promote the requalification of the residential context according to its particular features and environmental quality,
- 3. facilitate the population return to their homes.
- The Reconstruction Plans are the consequence of a multidisciplinary approach which involves the participation of different technicians.
- The contributions of architects, city planners and engineers were required in order to have a multilevel and complete study, starting from the analysis of each area on a large scale and focusing then on specific interventions.

It does not mean a sectorial approach but a continuative collaboration between all the parts involved.



SUBDIVISION OF THE TERRITORY IN HOMOGENEOUS AREAS







3. IDENTIFICATION AREA: CASTEL DEL MONTE



- wall-houses

3. IDENTIFICATION AREA: CASTELVECCHIO CALVISIO







- elliptical shape
- wall-houses
 - terraced house







3. IDENTIFICATION AREA: SANTO STEFANO DI SESSANIO



3. IDENTIFICATION AREA: VILLA SANTA LUCIA DEGLI ABRUZZI



- terraced houses
- contrast arches
- ruins



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4. METHODOLOGY OF THE STUDY: THE PILOT PROJECTS

Considering the Reconstruction Plans of Castel del Monte, Castelvecchio Calvisio, Santo Stefano di Sessanio and Villa Santa Lucia degli Abruzzi, some pilot projects were developed.

The pilot area is interested by town-planning and architectural actions and works which are intended to activate a **strategy on urban scale**, consistent with the Reconstruction Plan and the purpose to boost the economic upturn and the upswing of the land damaged by the earthquake.

The **methodology** applied:

- identification of the buildings and hypothesis about their historical evolution
- geometrical and structural survey
- critical survey
- simplified analysis of seismic vulnerability
- interventions proposal





Castelvecchio Calvisio



Santo Stefano di Sessanio



Villa Santa Lucia degli Abruzzi







Castel del Monte

4. METHODOLOGY OF THE STUDY: CLUSTERED BUILDINGS

NTC2008 §8.7.1 - Circolare 617 2/2/2009 §C8A.3

A clustered building is set of portions that are the result of an articulated and not unitary genesis, due to several factors (construction sequence, change in materials, change of needs, change of owners, etc.).

In the analysis of a building that is part of an aggregate building it is necessary to take into account **possible interactions** due to close structures, which are interconnected or simply adjacent, with the aim of reducing the fragmentation into single intervention to a minimum.







4. METHODOLOGY OF THE STUDY: GEOMETRICAL SURVEY

JS





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4. METHODOLOGY OF THE STUDY: STRUCTURAL SURVEY





ALTERATIONS, ADDITIONS, CHANGES



The structural survey allows to:

- understand the structural behaviour of the building
- discover the local construction rule
- identify alterations







Vertical structures



Horizontal structures





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4. METHODOLOGY OF THE STUDY: CRITICAL SURVEY









ANALYSIS OF THE CRACK PATTERN

- recognition of the causes of damage and of the main vulnerabilities
- identification of the activated mechanisms
- qualitative evaluation of the global behaviour





4. METHODOLOGY OF THE STUDY: SEISMIC VULNERABILITY ANALYSIS

NTC2008 §8.7.1

In existing masonry buildings under horizontal (seismic) loads, local and global mechanisms can develop.

The safety level of buildings must be evaluated against both types of mechanisms.



4. METHODOLOGY OF THE STUDY: SEISMIC VULNERABILITY ANALYSIS

NTC 2008 - BUILDING AGGREGATES

Circolare Min. delle Infr. e dei Trasp. n. 617 2/2/09

LGBC (Linee Guida per i Beni Culturali)

GLOBAL SIMPLIFIED EVALUATION FOR AGGREGATE BUILDINGS (§ C8A.3.1)

1. SEISMIC VULNERABILITY ANALYSIS



2. ANALISYS OF LOCAL MECHANISMS OF COLLAPSE (IN PLANE AND OUT OF PLANE)





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4. METHODOLOGY OF THE STUDY: SEISMIC VULNERABILITY ANALYSIS



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4. METHODOLOGY OF THE STUDY: SEISMIC VULNERABILITY ANALYSIS

OUT OF PLANE MECHANISMS

• Overturning of:

- Upper floors - Simply supported walls
- Vertical bending of walls

IN PLANE MECHANISMS





4. METHODOLOGY OF THE STUDY: SEISMIC VULNERABILITY ANALYSIS

OUT OF PLANE MECHANISMS

• Overturning of:

- Upper floors Simply supported walls
- Vertical bending of walls

IN PLANE MECHANISMS











4. METHODOLOGY OF THE STUDY: SEISMIC VULNERABILITY ANALYSIS

OUT OF PLANE MECHANISMS

• Overturning of:

- Upper floors
- Simply supported walls
- Vertical bending of walls

IN PLANE MECHANISMS









4. METHODOLOGY OF THE STUDY: SEISMIC VULNERABILITY ANALYSIS

OUT OF PLANE MECHANISMS

Overturning of:

•

- Simply supported walls 100 90 80 70 60 50 % verified 40 not verified 30 20 10 0 non-linear non-linear non-linear non-linear linear linear linear linear Castel del Monte Castelvecchio Calvisio Santo Stefano di Villa Santa Lucia degli Sessanio Abruzzi
- Upper floors





4. METHODOLOGY OF THE STUDY: INTERVENTION PROPOSALS

- **Restoration principles**
- Proposed actions compatible to the protection of architectural and historical heritage.









Intervention for the improvement of the connections





CHITECTURAL AND

Strengthening of the horizontal structures





4. METHODOLOGY OF THE STUDY: INTERVENTION PROPOSALS

- study of interventions for the restoration and the enhancement of ruined portions





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5. CONCLUSION

- The presented methodology allows creating an instrument for the Technical Offices of Municipalities that belong to the analyzed villages and for the professionals that will be involved in the reconstruction projects.
- The methodology is applied taking into account the historical centers features and allows assessing the vulnerability of the built and identifying appropriate seismic improvement interventions consistent with the principles of restoration.
- The technical work was integrated with the contribution of experts of urbanism and economics fields.







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