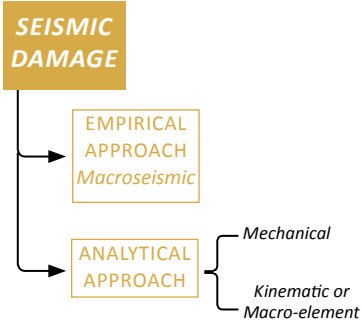


WP 1 BE and SUOD: State of the Art (SoA), risks and human behaviour

T1.2 - SoA of earthquake (SUOD) impact on BE and related earthquake-induced modifications due to building/aggregate and aggregate/public spaces interfering conditions. Current risk-reduction strategies analysis. Definition of human behavior including crowding conditions by combining SoA data and real-world events analysis

D1.2.2 - FACTORS INFLUENCING BUILDINGS/AGGREGATES, SURROUNDING OUTDOOR BE, MODIFICATIONS DURING THE EVENT








This deliverable presents a synthesis of the state of the art of the scientific literature concerning the preventive evaluation of the seismic damage of masonry buildings built with traditional techniques (unreinforced masonry - URM). The review of literature on this topic proposes significant contributions regarding analytical - experimental approaches and expeditious approaches, the latter more useful for studying large areas such as an entire historical center.

Furthermore, a topic of interest for the development of research in BE S²ECURE is the evaluation of how seismic damage to buildings can cause the fall of debris, creating an obstacle to

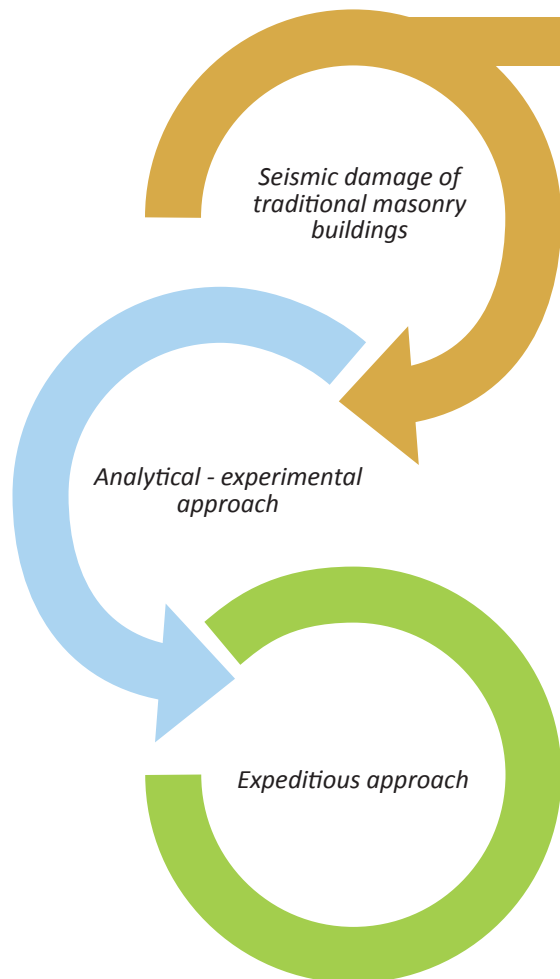
circulation in the streets and squares of historic centers. This assessment is very important since streets and squares perform an important function as elements that enable the safety of the inhabitants and the rescue of victims in the inhabited centers in case of natural disasters. With this regard, a state of the art of the main studies are presented providing elements for the definition of the tools to be used in order to preventively evaluate the changes that the earthquake produces on the built environment. it is possible identify two main category of methods: (i) analytical and experimental procedures, which require the use of specific fragility curves obtained through analytical assessment methods of vulnera-

Assessing the seismic damage of URM buildings has an indirect origin in the definition of macroseismic scales starting from the damage observed by buildings in the event of an earthquake. From these studies, methods have been developed that use different approaches dedicated to the evaluation of the building heritage located in a certain part of the urban territory (Macroseismic expeditious approaches) or focused on the behavior of individual buildings, with more complex analytical approaches (Mechanical or Kinematic).

Classification of damage to masonry buildings	
	Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage) Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases.
	Grade 2: Moderate damage (slight structural damage, moderate non-structural damage) Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys.
	Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage) Large and extensive cracks in most walls. Roof tiles detach. Chimney's fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
	Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage) Serious failure of walls; partial structural failure of roofs and floors.
	Grade 5: Destruction (very heavy structural damage) Total or near total collapse.

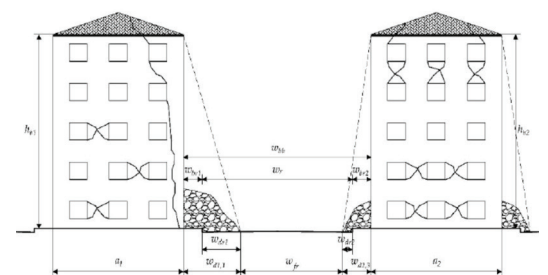
Source: EMS-98 Macroseismic scale (Grünthal, 1998)

The macroseismic approach constitutes the first level of the relationship between cause (earthquake intensity) and effects on buildings (levels of damage), considering the concept of vulnerability and thereby of their building characteristics. Subsequently, analytical approaches are based on the overall behavior of buildings performed through fragility curves and models. The kinematic approach relies on the real behavior of traditional buildings considering failure mechanisms due to the lack of "close-box" behavior.

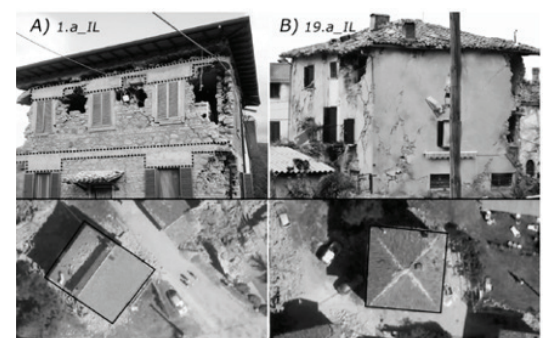


THE PROBLEM OF QUANTIFYING DEBRIS

ability; (ii) and expeditious approaches. Since the field of interest of the project concerns large areas of historical centres of Italian cities, methods based on detailed mechanical analyzes do not constitute a useful solution since, although more precise, they require high computational effort and time for the survey campaign. On the other hand, expeditious methods have sufficient reliability for the characterization of the behavior of a large number of buildings, although tend to present limitations for analysis focused on small and well-defined portions of the environment built. So that, a positive solution could be the application of analytical methods (performed for specific and relevant case studies) for evaluating corrections to be made to the expeditious procedures.



Source: Anelli, A., Mori, F., Vona, M. (2020) Fragility Curves of the Urban Road Network Based on the Debris Distributions of Interfering Buildings



Source: Bernardini, G., Lucasoli, M., Quaglinari, E. (2020) Sustainable planning of seismic emergency in historic centres through semiotic tools: Comparison of different existing methods through real case studies