POLYTECHNIC OF TORINO
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Degree in Architecture
Honors theses

Seismic vulnerability of historical centres. Employ of artificial intelligence techniques

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The high vulnerability to seismic actions in historic centres place the problem as a theme of public security in order to make plans and to reduce seismic risk.

For people and building's safety city councils must be enabled to make true forecasts on seismic damages. Actually the way to evaluate seismic vulnerability of masonry buildings in Italy is based on the analysis of information about features of constructive elements that are contained in schedules made by Gruppo Nazionale Difesa Terremoti G.N.D.T .

These schedules contains information about a single building that is described in dimensions ,shape, typology, and materials.

There is also a part where are described damages suffered by vertical and horizontal structures of the building.

In this work has been used a new way to evaluate the vulnerability(that is till experimenting in Politecnico di Torino) that use techniques of neural artificial intelligence ;starting from typology and constructive features of buildings ,using some parameters of G.N.D.T schedule (only more significant) the neural artificial net make forecasts of damage making classes of extension and intensity of damage using probability method.

Neural artificial net are elaboration systems of information that get inspiration from human nervous system .

A neural artificial net is made of a number of connected units called neurones, they must not be programmed ,but trained . This operation consist in to show a group of examples and allow the net to construct ,basing itself on a precise mechanism ,the internal knowledge to do the required task.

In mathematical terms means give a group of couples of vectors, an input vector and an output vector and do that the net find the relation between input and output (not a simple mathematical relation).The neural net has been trained on 756 cases of damaged buildings (by earthquake) located in Parma ,Teana, and Vesuvio and has been used in this work to do forecast of damage on a part of historic centre of Pinerolo (north Italy).

In order to make damage forecast on a complex aggregate of buildings like Pinerolo's it has been necessary the individuation of structural aggregates observing volumes ,materials and typology of the building because an historical reconstruction was impossible. After this a lot of investigations has been made in order to find the parameters needed to the net .

They are:

1. Maximum height of the building
2. Last structural intervention
3. Stairs typology
4. Vertical structure's typology
5. Horizontal structure's typology
6. Roof's typology
7. Resistant system's typology and organisation
8. Resistant system's quality
9. Building's position and foundations
10. Horizontal system
11. Planimetrical's shape
12. Elevation's shape
13. Roof

For each one of these parameters there is a numeric or literal value .
Before the elaboration process is necessary translate all in vectors so that each building is represented by a vector. Damage forecast is expressed in 4 parameters: extension and level of damage on vertical and horizontal structures.

Damage level is classified by 3 degrees:

1. Light
2. Medium
3. Strong , very strong

After the damage scheme given by the net has been hipotized to make anti-seismic improvement on each structural element and appraise damages after each one of the improvements, that are:

After each anti-seismic intervention has been made a forecast of damage in order to evaluate the utility of the intervention.

The ipotetic intervention are:

1. Elimination of earth shaw
2. Anti-seismic improvement of masonry (light)
3. Anti-seismic improvement of masonry (strong)
4. Intervention of substitution of stair
5. Intervention of repair of horizontal structures
6. Intervention of substitution of horizontal structures
7. Anti-seismic improvement of roof
8. Multiple anti-seismic improvement
9. Global anti-seismic improvement

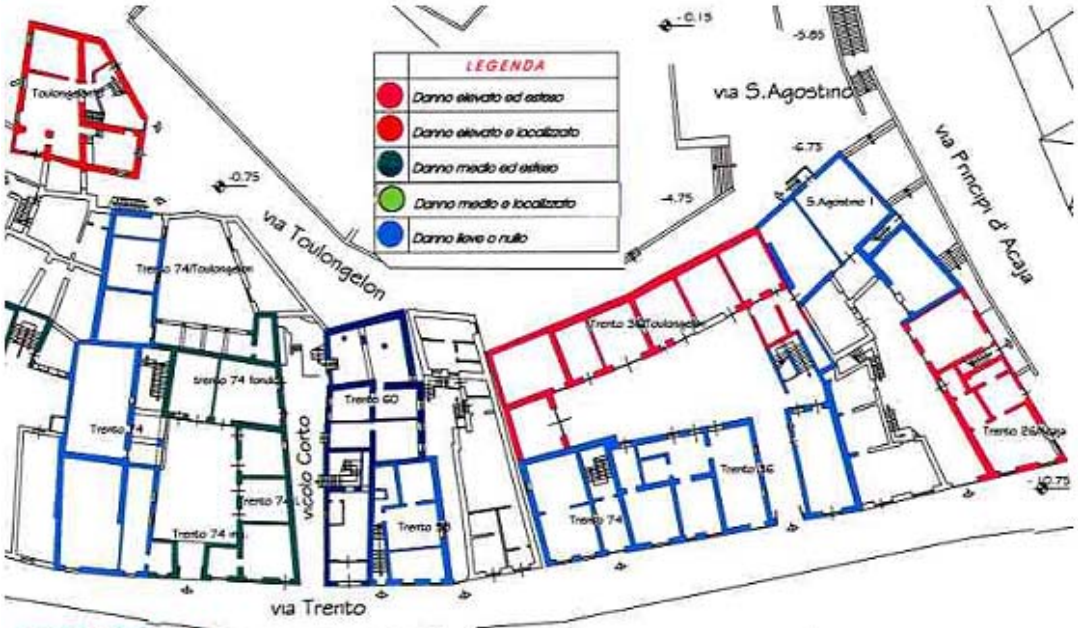

FIGURA 1 Estratto di planta della zona analizzata che mostra lo scenario di danno previsto nella situazione iniziale senza interventi antisismici

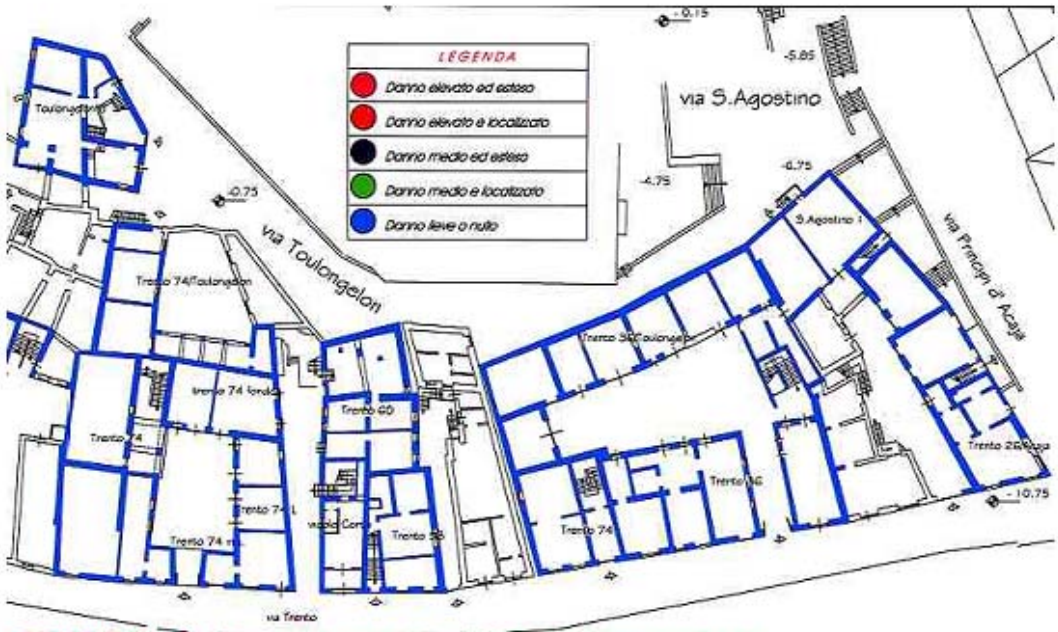

FIGURA 2 Estratto di planta della zona analizzata che mostra lo scenario di danno previsto dopo il miglioramento antisismico globale

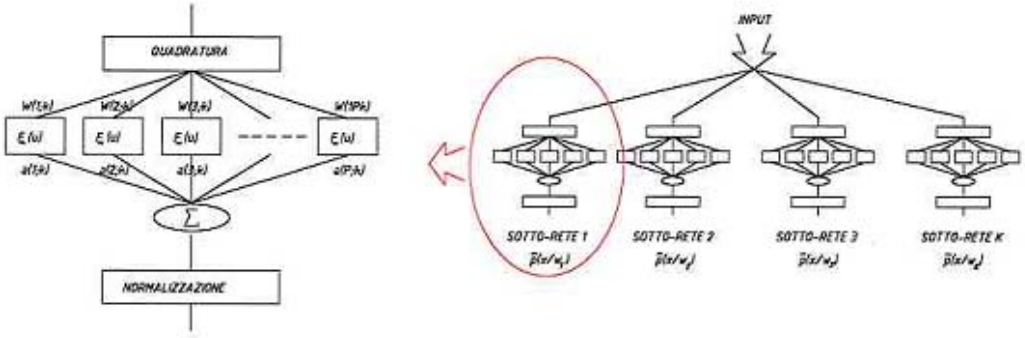

FIGURA 3 : Schema di una rete neurale e delle sottoreti che la compongono.

The intervention 8 and 9 contains more structural elements. In fig. 1 there is the damage forecastwithout intervention, while in fig. 2 is shown the forecast of damage after the Global anti-seismic improvement .
The zone contains also medieval building ,the senato palace. For this case has been ipotized anti seismic improvement compatible with tutelary of ancient buildings.