Local Disaster Reduction in the Municipality of Lezha

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Methodology

The methodology comprises several factors:

1. Legal requirements (Jurisdictional). The first phase consist od a legal orientation and is concerned with procuring the essential permits from the municipality or other component institutions.

2. The selection of competent architects and structural engineers. According th Albanian law, engineers who will address this issue must be registred as structural engineers with the appropiate license. Professionals must have demonstrated expertise in the analysis, designm and retrofitting of structures in seismically active regions. Experts should also be acquainted with the engineering and design principles of seismic performance engineering. Experience with inelastic analysis procedures and knowledge of the behavior of various structural materials are required to conudct such an analysis. Lastly, it is necessary to have a fundamental comprehesion of structural dynamics and the behavior of various structures subjected to ground motion.

3. Establishing performance goals

This stage relates to the determination of the structure's performance objectives using empirical or analytical methods, which include: Structural stability Limited security Life insurance Damage control Immediate use.

4.Structure assessment

Through thorough inspection, the goal is to collect data regarding existing structural designs, material resistance, potential interventions, and previous damage. This inspection can be conducted in:

5.Drawings Control Visual Inspection Preliminary Calculations

Identifying Seismic Capacity

Using advanced modeling and analytical techniques, capacity curves are derived, allowing for a comprehensive evaluation of building design by capacity. Empirical methods, based on visual inspection for damage to the primary structural elements, and analytical methods, based on the characteristics of materials, the details of construction, the method of modeling, and the results of this model (force-displacement curves), are utilized.

6. Establishment of seismic necessities

This phase relates to seismic hazards, capacity interaction, and displacement targets.

7. Assessment of seismic efficacy

After the performance point has been evaluated, the engineer verifies the performance of the building using acceptability criteria, and the results are used to inform the government's decision-making process, taking safety and risk into consideration.

8.Determining whether it requires restoration, reinforcement, or demolition.

The group of engineers determines whether the examined object will be repaired, reinforced using various techniques, or demolished based on the results of the preceding phases. Traditional or contemporary techniques determine the choice of reinforcement technique.

9.Documentation preparation and quality control monitoring

The final phase is concerned with the quality of the construction through documentation, testing, and inspections.

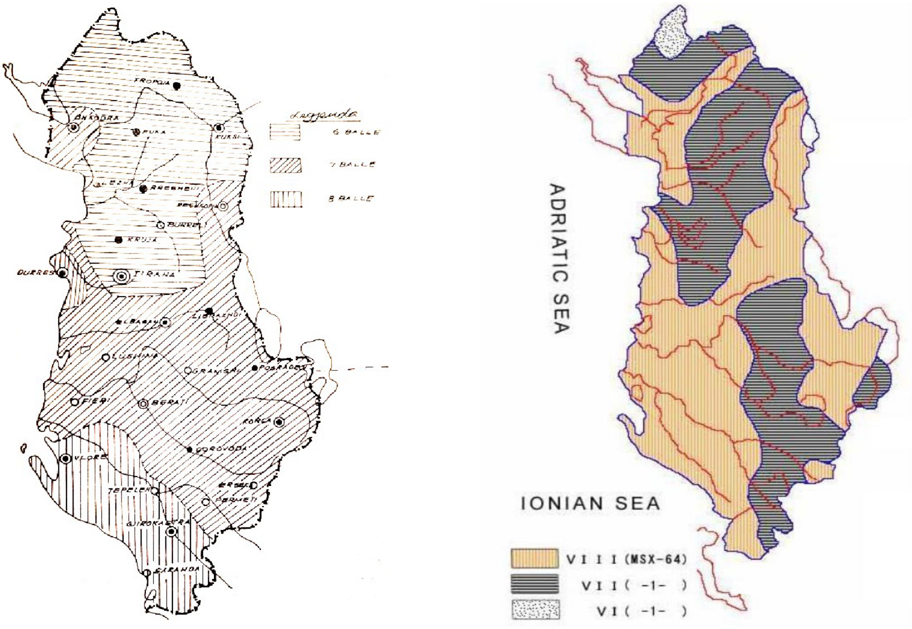

Fig 1a) Seismic zoning according to Intensity in 1963 and 1978 b) Seismic zoning according to Intensity used since 1989 (source: IGJEUM)

The designer will verify existing conditions and supervise construction.

2. Overview of Facilities

2.1. Design codes

Since the time of communism until the present day, the design regulations in Albania have changed and been updated in response to various demands. In terms of construction and codes, Albania's temporary situation is as follows:

▪ Construction codes before the 1990s

The construction industry was public, centrally regulated, and administered. It was the responsibility of the Ministry of Construction and four international institutes to develop building regulations and design public infrastructure and facilities. Russia proposed the first design code, followed by the KTP (Technical Design Conditions) KTP-52 in 1952, KTP-63 in 1963, KTP 1,2,3,4,5,6,7,8,9 in 1978, and KTP-89 in 1989.

As defined by these protocols, seismic force is as follows:

(Seismic pressure based on KTP 78)

$$S_k = Q_k \cdot k_E \cdot \beta \cdot m_k$$

(Seismic pressure based on KTP-N2-89)

$$E_{ki} = K_E \cdot K_r \cdot \psi \cdot \beta_i \cdot \eta_{ki} \cdot Q_k$$

Each of the parameters presented in the preceding formula is determined by four primary factors:

The classification of property, according to national standards (KTP), is divided into three categories.

Category I (strengthened)

Category II (moderate)

c. Classification III (thin deposits)

2. Earthquake intensity based on MSK-64, which can be found on maps provided by seismology institutions based on two different time periods: the 1963 map and the 1978 map. Based on these maps, Albania is divided into regions of 6, 7, 8, and 9 intensity.

The significance of an object based on its function. KTP categorizes the facilities into five distinct groups.

Number of storeys

▪ Building regulations following the 1990s

From 1989 to the 2000s, neither state control nor building regulations were enforced in Albania, despite the construction industry's significant growth. In 2001, the Ministry of Foreign Affairs organized a symposium on the significance of Eurocodes in the construction industry. Following the workshop, a group of engineers was formed to translate and modify Eurocodes to national guidelines over the course of several years. In conjunction with the task, these protocols served only as blueprints and not as specialist-specific instructions. The Albanian government did not authorize the untranslated version of Eurocode 8 until after the earthquake of November 26, 2019.

Based on Eurocode 8, the following information is utilized for the seismic design of the structure:

1. Peak ground acceleration (PGA) maps, which display acceleration values in g. The Lezha PGA map is depicted in figure 2:

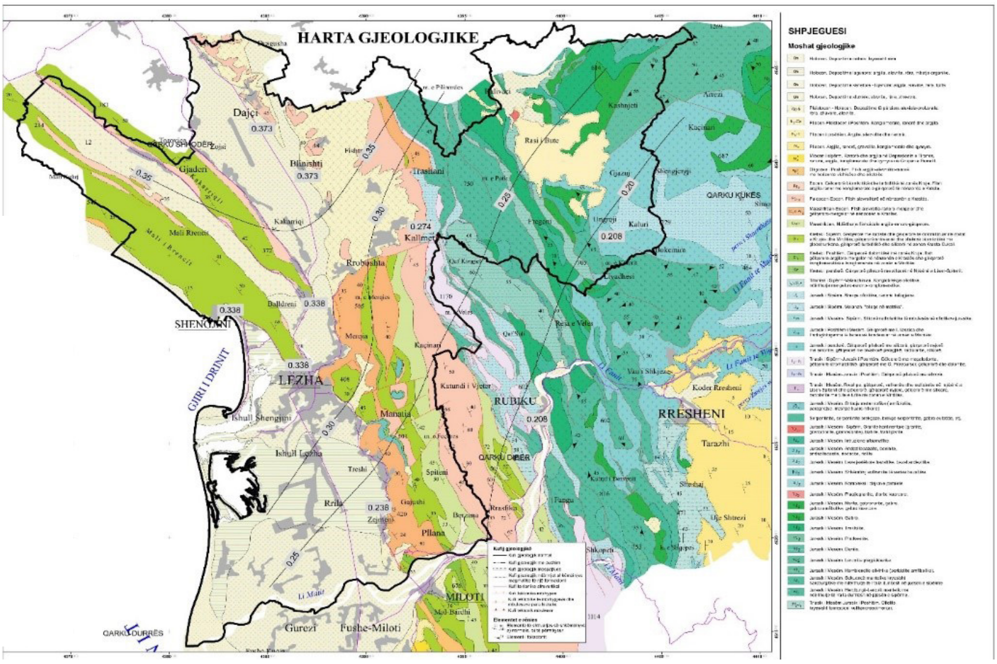

Fig 2. Map of maximum acceleration in Lezha municipality (source: CoPlan)

The land category determined by the values of Vs, NSPT, and Cu is as follows:
a. Category of soil A b. Category of soil B c. Category of soil C d. Category of soil D
e. Soil type E p. Special soil types S1 and S2
Figure 3 depicts the distribution of land categories within the municipality of Lezha.

We extract the elastic response spectrum and then the design spectrum based on the obtained data. The response spectrum is crucial for determining how a system with one degree of freedom responds to seismic action.

2.1. Structural typologies
2.2.1. Classification of types of structures according to their construction period:
From 1945 to the present day, various structural typologies have been utilized in Albania and, consequently, in Lezha, as can be summarized as follows:
During the period between 1945 and 1960, many low-rise buildings were constructed with masonry construction. Few structures were constructed with other materials, such as concrete, steel, or wood.

2. From 1960 to 1979, as a result of seismic activity, a number of modifications were made to masonry structures: the quality of materials improved significantly, and new structural elements, such as reinforced concrete belts, architraves in windows and doors, and prefabricated and ceramic slabs, were added. Prefabricated structures were introduced as a building type for industrial and residential structures.
From 1979 to 1990, additional enhancements were made to increase the structure's resistance to seismic force. At the corners and intersections of the walls, reinforced iron columns were added and the connections were improved. Each column was secured with anti-seismic cables. In addition to the use of masonry structures, the use of prefabricated buildings persisted. During this time, the first reinforced concrete structure of significant height was constructed in Tirana, a 15-story hotel that continues to operate today.
From the 1990s to the 2000s, a new construction period is introduced, referring to the structural typology used for low and tall buildings. During this time period, reinforced concrete was widely used and masonry construction ceased.
5. With the introduction of the Eurocodes in the year 2000, significant developments were made in relation to the structure's typology, which were centered on the classification provided by this code: reinforced concrete buildings (frames, shear walls, core system), steel buildings, wood and composite buildings.

2.2.2 Classification of typologies in accordance with the structural system and placement
In order to determine a facility's response to a hazardous event, it is crucial that the facilities are accurately classified according to their structural types. For the case of Lezha, the map below and Table 1 summarize the typologies and their

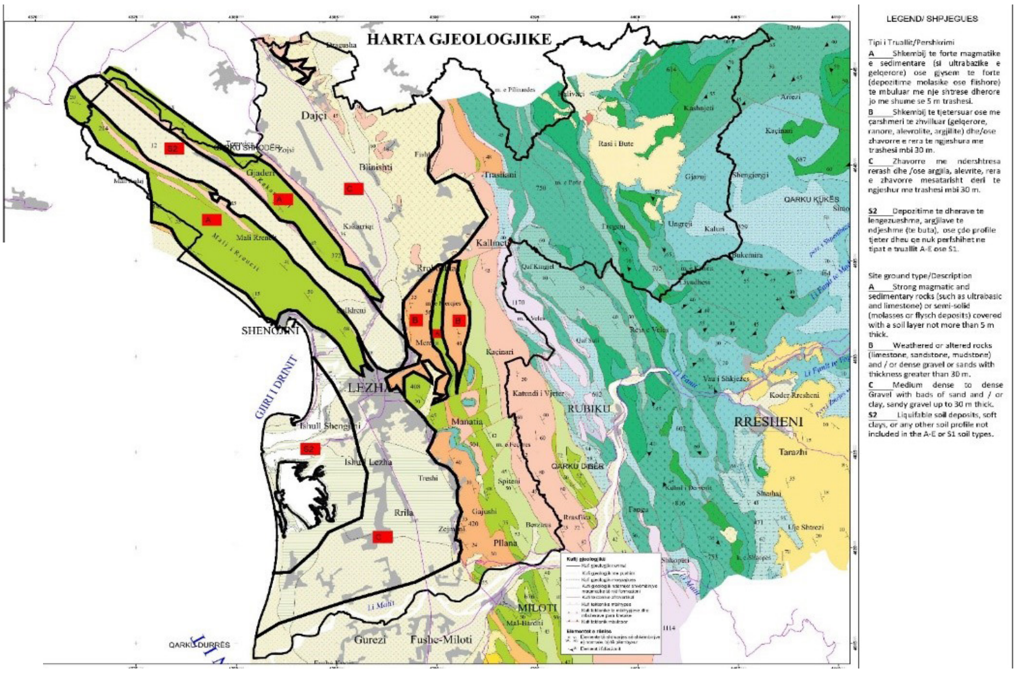

Fig. 3. Land classification map based on EN-1998 of Lezha municipality (source: CoPlan)

distribution in the territory.
Risk typologies

For each of the preceding types, a damage analysis will be conducted for the four primary actions:
1. deterioration due to age and environmental conditions

2. damage caused by human activities

3. damages caused by foundation subsidence

4. harm caused by seismic activity

2.3. Buildings made of unreinforced and reinforced masonry

5. deterioration owing to age and environmental conditions
Numerous damages result from an object's exposure to atmospheric agents, which can be enumerated as follows:
Damage from material deterioration Carbonation and sulfate deterioration Erosion Freeze-thaw deterioration Strain effects:

a. Damage caused by human action
After the 1990s, residents made modifications to all of these structures in order to obtain more space in their dwellings. The interventions have altered the efficacy of these objects, leading to an increase in their potential for injury. Over existing levels, interventions can be classified as vertical or horizontal extensions. The water deposits on the terraces and the use of the veranda for a variety of purposes are defining characteristics of this typology.
b. Damage caused by foundation settlement
This foundation type consists of concrete or stone beam foundations that are susceptible to subsidence due to their own weight and soil conditions. The region of Lezha is primarily comprised of deposits of unstable soils, which explains why some structures have experienced differential subsidence, resulting in fractures in the masonry.
c. Damage caused by earthquakes
Lezha, like the rest of Albania, is vulnerable to earthquakes with PGA values between 0.25g and 0.37g. The effects of an earthquake on this form of structure can be divided into two categories:
Wall damage caused by forces acting on the wall's own plane
Wall damage caused by transverse forces acting outside the wall's plane

2.4 Prefabricated and industrial frame structures

Although prefabricated buildings are prevalent in Albania, as noted in the classification based on construction period, the majority of prefabricated structures in Lezha are located on Frang Bardhi Street. The technology involves

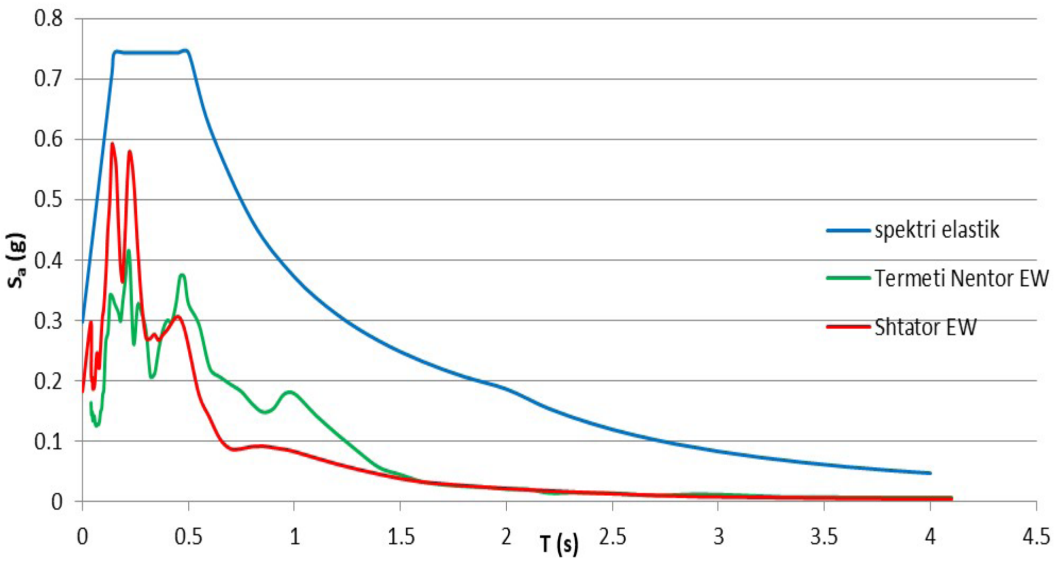

Fig. 4 Examples of response spectrum based on EN-1998 (source: EN-1998)

riveting together prefabricated panels and utilizing other prefabricated elements such as beams and slabs.
These objects are susceptible to deterioration and damage to these structural elements, which can be categorized into two large groups: a) structural, when the damage (fissures) are in the wall panels and/or slabs and/or in the connection of, and b) non-structural, such as cracks in the stucco. In this study, technical recommendations are provided for the decision-making bodies regarding the management of the seismic risk posed by analogous earthquakes to these structures.
2.5. Reinforced concrete structure
The type of reinforced system closely correlates with the severity of damage to these structures. In framed systems, for instance, the orientation of the frame is the primary determinant of damage to joints and partition walls (column orientation); in dual systems or walled systems, incorrect distribution of shear walls can cause connection issues. with twisting that can compromise the structural stability of the building. Concerning deterioration due to atmospheric actions, this type has the following issues:
▪ Erosion can damage the protective layer of concrete, exposing the reinforcement and making it susceptible to erosion (corrosion).
▪ Degradation from the freezing-thawing process
▪ Carbonization – sulfate degradation.

3. Evidence of possible risks for social and cultural objects

3.1. Objects of special importance (school, stadium, hospital)

This category includes objects of special importance for the city which must be designed taking special cases into consideration.
The first category is the schools and in Lezha there are a total of 59 primary schools, 13 secondary schools (gymnasium) and 1 vocational school.

The second category is hospitals and health centers, in Lezha there are 3 hospitals with 319 beds and 92 health centers.
Lezha is a municipality that has a large number of monuments with historical value that must be preserved, which are: Shna Ndou, Saint Barbull church, Saint Mhill, Saint Eufemi church, etc. Lezha castle, Shkina bridge, Gjergj Fishta's house, etc.

4. Possible interventions to reduce the seismic risk
The final phase is that of reducing the risk placed in these buildings. This can be done based on several criteria that include the level of damage, structural typology, etc.
Improving seismic performance includes:
Less damage
Greater rigidity
Increased bending capacity
Increase in ductility
Increased towing capacity
Increase in cutting capacity
In the case of masonry constructions, seismic retrofit can be done in two methods explained below:

Fig. 5 Examples of structures from 1945 to 1960 in the municipality of Lezhë

Fig. 6 Examples of structures from 1960 to 1979 in the municipality of Lezhë

1.Seismic masonry retrofit with "traditional" techniques include in-plane and out-of-plane interventions, in-plane cuts and perimeter reinforcement methods using the following techniques:

Injection of mortar or resin through gaps in the wall
Improvement of wall anchoring
Plaster reinforced with steel mesh
Reinforcement with concrete bands
Repair of local cracks in masonry
Placement of metal braces
Placement of metal rods and plates
Three dimensional connecting system
Use of secondary frames, etc

2. Seismic retrofit of masonry with "modern" techniques
Fiber Reinforcing Polymer (FRP)
Textile reinforced mortar (TRM)
▪ GFRP; CFRP; AFRP
For reinforced concrete constructions, the retrofit techniques used are as follows:
Steel band shirt
Composite fibers
Metal diagonals
Adding walls to cuts
Concrete diaphragm
Improving the connection between the walls and the horizontal diaphragm
Fiber Reinforcing Polymer (FRP)
Intervention techniques can be considered as break-rebuild intervention using these principles:
minimal intervention
wall protection
use of identical substitute materials
additions designed to be consistent with the style of the original building

5. Conclusions and Recommendations.
Due to the fact that the performance of each structure under the action of the earthquake varies, it is necessary to carefully examine the performance of each building using the appropriate methodology, and depending on the results, appropriate reinforcement measures should be considered when necessary. To achieve this, it is necessary to classify structures based on a variety of factors, such as construction time, material quality, and structural system. In addition to classification, maps that display PGA values and geological configuration are also crucial. Based on the methodology described at the outset of this document, the purpose of this report was to provide an overview of the collapse mechanism by analyzing the structural system. The evaluation was based solely on visual inspections, including a thorough examination of photographs and site visits.
Theoretically, several techniques for improving the seismic performance of various structural systems are presented. In the case of Lezha described in chapter 4, some of the techniques mentioned were utilized. Using the technologies described in this report, some of these structures

Fig. 7 Examples of structures from 1979 to 1990 in the municipality of Lezhë

Fig. 8 Examples of structures from 1990 to 2000 in the municipality of Lezhë

were reinforced six months after the earthquake. On the basis of the 2004 New Zealand Building Act's experience, it is necessary to establish a percentage of seismic resistance below which the building is deemed to be affected relative to new construction standards. In New Zealand, this proportion is approximately 34%. Referenced Charleson, A. "...after the destruction caused by the Durres earthquake, Albanian architects must avoid the incompatibility between the rigid external and internal masonry and the flexible reinforced concrete skeleton," which undoubtedly applies to the city of Lezha.

Taking into account the aforementioned conclusions and recommendations, the relevant bodies can implement the following interventions and measures:

The creation of a database containing crucial information about constructions. This database contains information in the form of tables, diagrams, and maps that can provide an overview of the construction dates of buildings. construction and structural typology and existing performance-enhancing interventions.

Employing specialized structural engineers is crucial for the creation of this database.

On the basis of the information in this database and the advanced analysis provided by the methodology at the outset of the report, it is possible to assess the earthquake risk in each building. Thus, a pre-earthquake evaluation can be conducted in lieu of post-earthquake interventions. This risk will be communicated to the decision-makers.

Lezha can use the knowledge provided by New Zealand to determine whether a structure is susceptible to earthquakes or not. The percentage of structures considered to be at risk from earthquakes in a municipality (34 percent in New Zealand) can be determined with precision by municipally employed engineers. This percentage is also significant because it relates closely to the economic aspect. In the case of interventions, a certain amount of time must be allowed for the construction to be improved after obtaining the results. The relevant authority sets the deadline, and if the proprietor fails to comply, the object will be incinerated.

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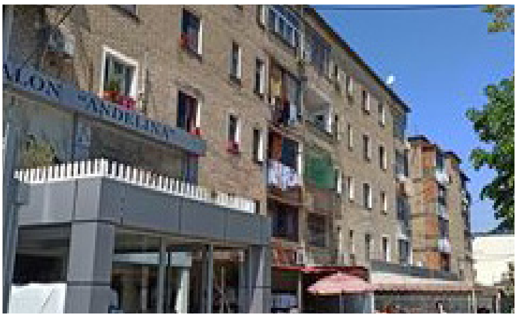
Fig. 9 Examples of structures after the year 2000 in Lezhë municipality



Nr | Typology of the structural system

1. Existing structures with unreinforced masonry

   -"Convenant" area
   -"Collection" area
   Between Kosova Street and Gjergj Fishta Boulevard
   Along the "Mother Teresa" Boulevard in Shengjin.

2. Existing masonry structures with unreinforced with anti-seismic bands and columns

   -"Convenant" area
   -"Collection" area

   Between Kosova Street and Gjergj Fishta Boulevard

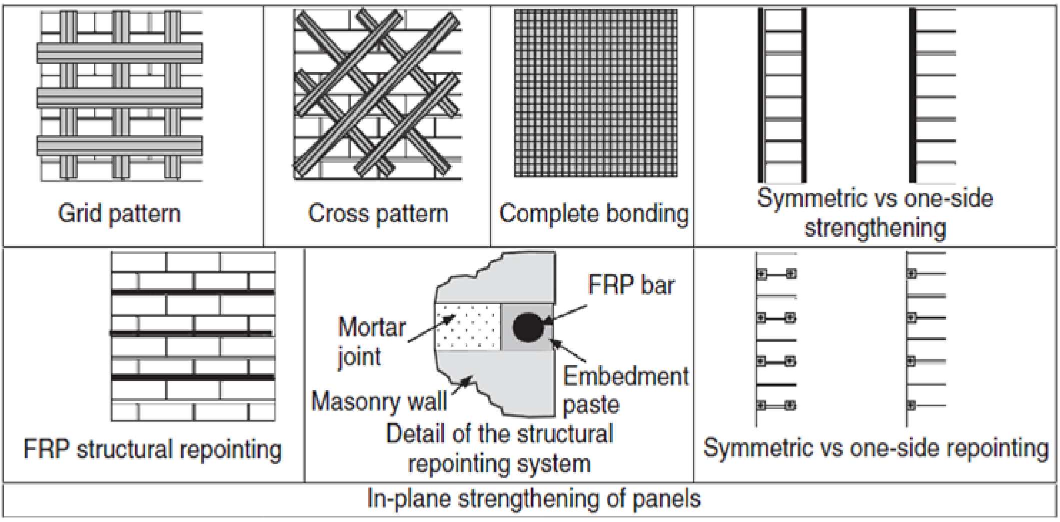
   Along the "Mother Teresa" Boulevard in Shengjin.

3. Prefab buildings

   -Along Frang Bardhi street

4. Buildings with reinforced concrete system
   Building with reinforced concrete structural system:
   -Rama
   -Walls
   -Dual
   -Pendulum included

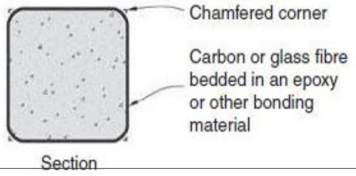
   The "Beselidhja" area is located on Franz Jozef Strauss Street
   Between "Plazh Center" and "Shengjin Center"



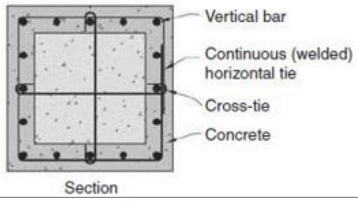
Examples of reinforcement with 'modern' techniques for masonry buildings

a) Structural damage in the beam b) FRP reinforcement in the beam c) close-up view of the reinforcement d) non-structural damage (partition walls)

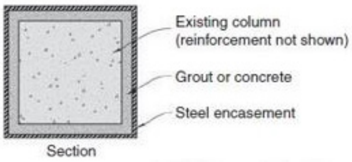
1. Composite fibers



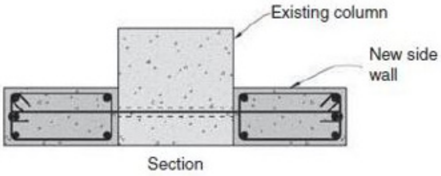
2. Concrete-weapon shirt



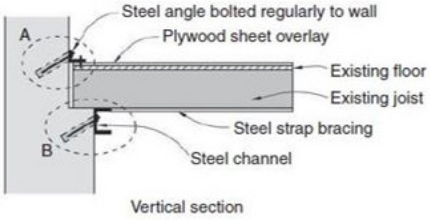
3. Shirt with steel stripes



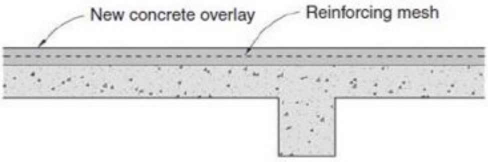
4. Column reinforcement with side walls



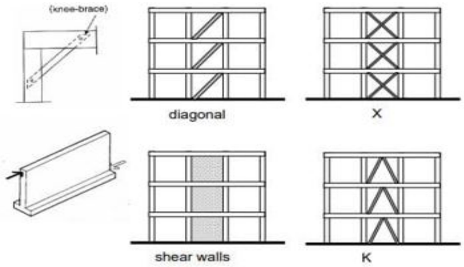
5. Diaphragms in wall joints



6. New concrete cover



7. Diagonals



8. Fiber Reinforced Polymer (FRP)