Rehabilitation of existing buildings and structures to resist seismic acts

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Abstract

This research aimed to explain a set of concepts that reduce the seismic hazard of existing buildings and structures by clarifying the philosophy of earthquake-resistant design, and to clarify the descriptive or detailed descriptive methods adopted in references and codes**.** The researcher has used the descriptive approach to achieve the objectives of the study. This approach is based on reference to studies, articles and books related to the current subject to achieve the objectives of the study. The research concluded that there are many methods used in strengthening existing buildings and installations in earthquake-prone areas. The most important of these methods are making the necessary corrections related to the general structural configuration such as reducing the wicks by removing and adding the cutters, and reducing the vertical order by adding structural walls and repairing the shear in the structural elements by reinforcing the columns by adding steel shirts or layers of pure concrete.

Key words: Rehabilitation, Existing buildings, Resist seismic.

1.0 Introduction

Many countries of the world are exposed to earthquakes of various degrees (large, medium, weak). And the Middle East region is considered from the areas that are exposed to seismic hazard. Hence, the subject of seismic protection should be addressed in designing the subsequent structures to resist earthquakes and protect existing buildings and installations. Hwaija (2005) stressed that this protection can be guaranteed by strengthening buildings and structures and rehabilitating them to make them able to withstand seismic forces.

The concept of seismic protection strives to preserve human life, protect the structure of construction fundamentally, and the safety of non-structural elements comes in the second order. Holmes (2000) clarified that when an earthquake of relatively high magnitude can occur, the structure of the building can remain intact without damage, while the non-structural elements are almost completely destroyed.

Rai (2005) stressed that the non-structural elements are very expensive elements, and its collapse will result in a temporary suspension of investment building, which in turn causes material and vital losses for vital institutions, whether service or productive, and therefore the attention to these elements is essential.

2.0 Research importance

The aim of this research is to explain a set of concepts that reduce the seismic hazard of existing buildings and structures by clarifying the philosophy of earthquake-resistant design, and clarifying the descriptive or detailed descriptive methods adopted in references and codes. And then take the appropriate decision for the reform or restoration process in order to:

1. Prevent the collapse of buildings during the earthquake to maintain the integrity of the investor.

2. Reduce damage to ensure continuity of work during and after the earthquake.

It is very important to distinguish between the concept of rehabilitation and the concept of reform or restoration, since the last one is concerned with damaged facilities, while rehabilitation may not necessarily concerned with damaged facilities. Seismic rehabilitation is a procedure used by the structural engineer to strengthen existing facilities to resist future earthquakes (Gülkan and Wasti, 2009).

3.0 Research methodology

The researcher will use the descriptive approach to achieve the objectives of the study. This approach is based on reference to studies, articles and books related to the current subject to achieve the objectives of the study.

4.0 Literature review

4.1 Seismic Design Philosophy

Seismic design is certainly different from the classic design that is resistant to other loads that other installations are exposed to, such as gravity and wind. Despite the rapid development and good understanding of the structural behavior of buildings prone to seismic events, there are significant differences in most countries between the theories of seismic engineering and their applications at the design and applied levels (Wenk, 2008).

It is noted that there are many buildings damaged or collapsed due to non-application of what is stated in the international seismic codes. Rutherford & Chekene (2006) pointed out that the most prominent collapses to buildings are collapses due to the bad enclosure of the longitudinal armament in the columns and collapses in the weak link.

The various mechanisms of collapse do not agree with the philosophy of seismic design, which aims to raise the structural efficiency and improve the behavior of elements by focusing on the concept of mutability rather than relying on the concept of resistance only (Wenk, 2008). The inflexible construction response has become a reality in the earthquake-resistant construction design. Sahin (2014) indicated that the most important factors affecting the design of buildings and buildings resistant to earthquakes are:

1. Acceptable hazard associated with earthquake frequency: it includes designing the important installations such as bridges and hospitals on large seismic shocks, unlike residential buildings.
2. Economic considerations: The choice of design intensity varies from country to country for various reasons such as the initial cost of construction, maintenance costs, loss due to deteriorating construction condition under investment.
3. The importance of construction and the consequences of its collapse.

Stratan (2015) clarified that the shear factor is associated with a combination of factors such as the seismic zone studied, the importance of origin, the behavior of the origin, the dynamic response of the vibrations produced during a particular earthquake, and the interaction between origin and foundation soil. Ersoy et al. (2015) stated that the effect of seismic forces can be improved by improving the seismic response of the origin by selecting the appropriate architectural form, which includes simplicity, symmetry, avoidance of sediment in U. L, T, and the hardness of the floors.

4.2 The evaluation of existing buildings and structures for earthquake resistance

The process of evaluating the existing buildings and facilities aims to determine the degree of public safety and to demonstrate the efficiency of the resistance to the seismic acts of the site studied, and then take the appropriate decision to strengthen or demolish (Dubina et al., 2014). Vulcu et al. (2012) noted that the assessment process is a major primary step in the seismic risk mitigation program and includes the following phases:

1. Identifying and classifying building models, clarifying all modifications (if any), and developing a plan to study seismic safety of existing buildings according to their importance.
2. Investing the data of the previous step to develop a set of procedures and qualitative requirements so that the program is implemented based on a set of questions related to the properties of buildings and facilities erected.
3. Analyzing the buildings with their damaged condition, taking into account the properties of actual materials and loads.

4.3 Strengthening and rehabilitating existing buildings and facilities - strengthening techniques

Strengthening and rehabilitating existing buildings and facilities - strengthening techniques

When an existing building must be strengthened, attention must be paid to the following factors (Hwaija, 2005):

1. The level required for the structural resistance of the building
2. General structure and change required.
3. Materials of reinforcing elements and their degree of contact with the existing construction.
4. The condition of the foundations and the possibility of building above them.
5. Period of time for non-investment of construction
6. The cost of reinforcement

The efficiency of existing buildings and facilities can be increased by one of the following methods (Vulcu et al., 2012):

1. Minimizing the effect of seismic action.
2. Improving the mechanical properties of the building (resistance, hardness, the role of vibration), through:

A. Reducing the building block by removing a certain number of floors or by reducing the weight of the walls and the density of their distribution.
B. Minimizing the distance between the center of gravity and the center of hardness to minimize the effects of the wick.
C. Increasing moderation by connecting the structural elements of horizontal forces to each other.

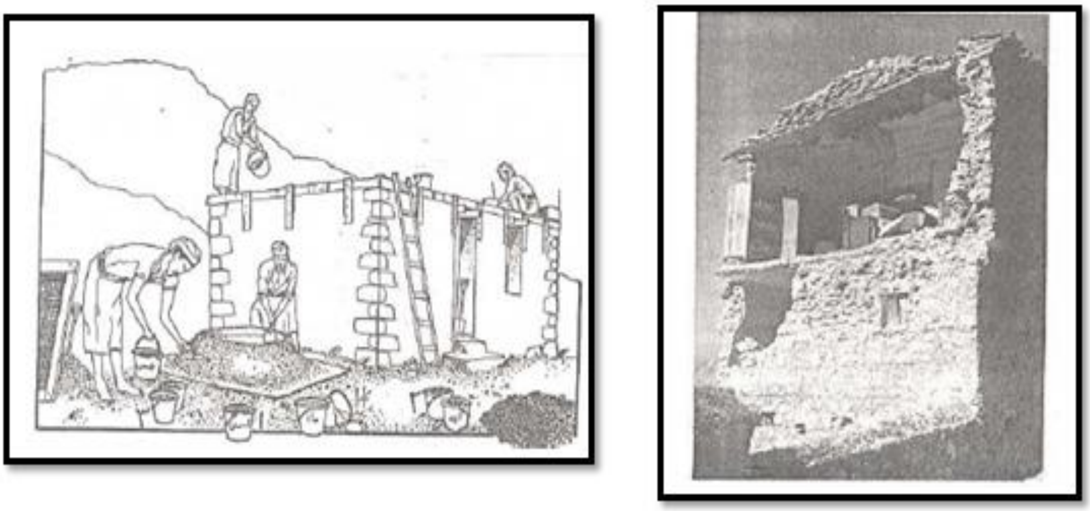
3. Increasing the number of elements resistant to horizontal forces, this contributes to reducing the risk of collapse of one.

4.4 State of unarmed stone buildings

This type of building has many weaknesses in terms of seismic resistance and can be strengthened in the following ways (Hwaija, 2005):

1. Make adjustments in the construction mismatch to reduce asymmetry.
2. Improved communication when orthogonal walls converge by means of steel bolts.
3. Strengthen the wooden hulls by increasing their hardness by covering them with a thin layer of reinforced concrete, or removing the roof, thereby improving their connection to the bearing walls.
4. Reinforcing the walls especially when they are cracked with cement.
5. Strengthening foundations.

The following Figures (Figure 1, Figure 2) represent examples for methods used for strengthening seismic resistance.



Improvement of building techniques after Yemen earthquake 1982 (stone buildings)

Double stone buildings to resist earthquakes (The 1980 earthquake in Italy)

Figure 1: Methods used for strengthening seismic resistance (Hwaija, 2005)

Figure 2: Reinforcement of old or damaged stone building using internal and external reinforcement coated with a layer of soft concrete (Hwaija, 2005)

4.5 Status of existing buildings of reinforced concrete

There are many methods used for seismic rehabilitation of existing concrete structures, including:

1. Provide the columns with armed concrete or steel: This solution is economical, and contributes to the lifting of resistance of origin. In contrast, this work affects the mechanical properties of the origin when used alone.

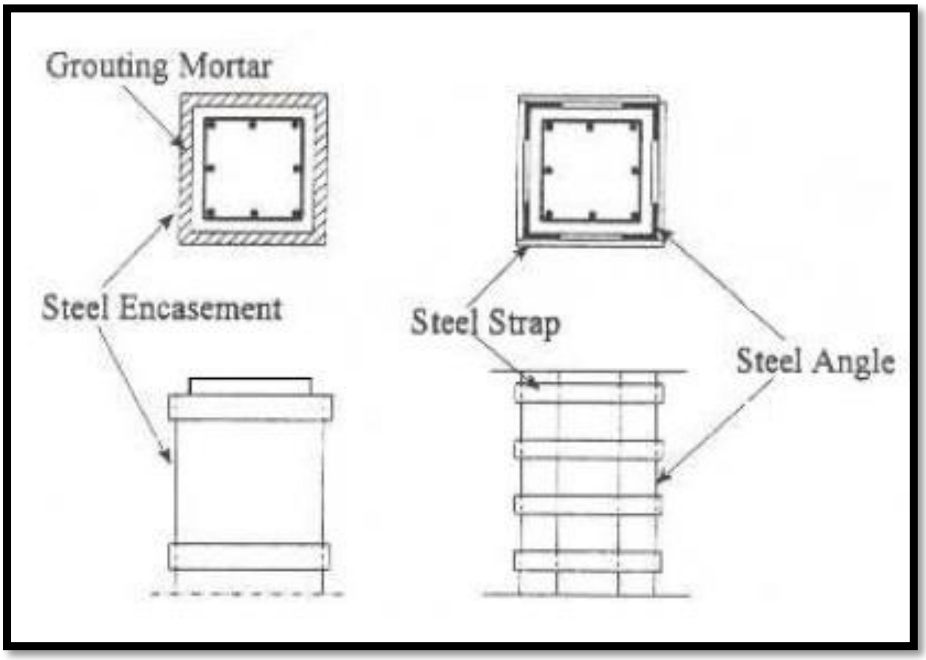


Figure 2: Reinforcing columns using steel sections (Hwaija, 2005)

2. Add reinforced concrete walls: these walls increase the side hardness and resistance of origin.

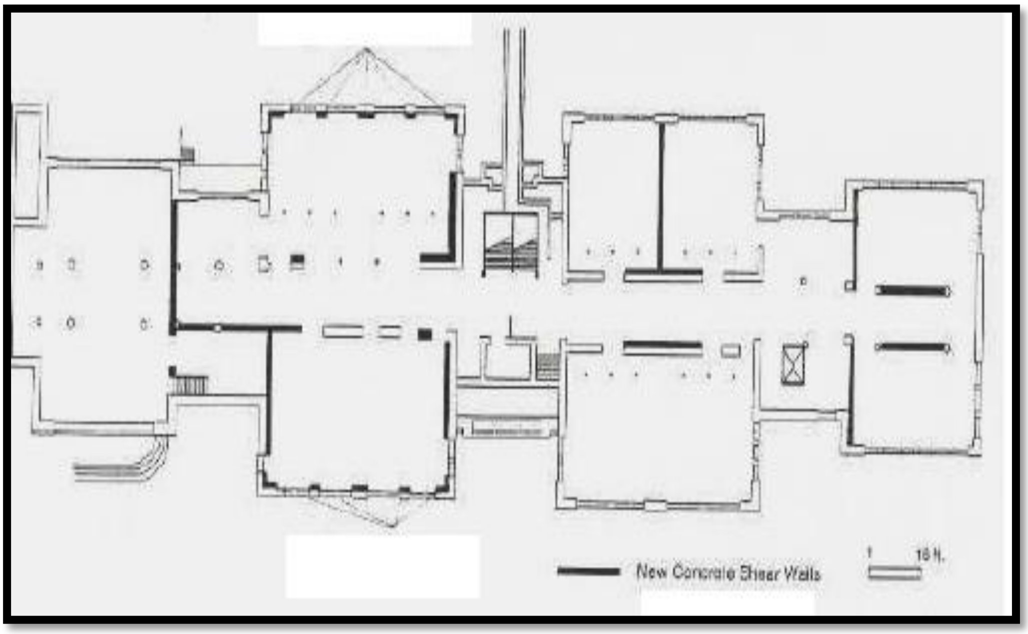


Figure 3 :Rehabilitation of a school in Chicago by adding walls to resist earthquakes (Gajanan et al., 1996)

3. Use walls filled with external tires to reduce horizontal transitions.
4. Remove or redesign non-structural walls.
5. Increase the hardness of high construction built on soft soil.
6. Add surrounding frames that improve lateral hardness and resistance.

5.0 Conclusion

The study aimed to explain a number of basic factors that reduce seismic risk. The study also aimed to explain the methods of earthquake-resistant reinforcement and offer appropriate techniques in strengthening existing buildings and installations in earthquake-prone areas, which can be summarized as follows:

1. Making the necessary corrections related to the general structural configuration such as reducing the wicks by removing and adding the cutters, and reducing the vertical order by adding structural walls.

2. Repairing the shear in the structural elements by reinforcing the columns by adding steel shirts or layers of pure concrete.

Finally, the choice of seismic technology requires engineering wisdom linked to various factors, including economic considerations, the nature of an enterprise's investment, and architectural considerations.

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