Original Article: Identifying Types of Vulnerable Structures in Urban and Rural Areas against the Occurrence of Earthquakes

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ABSTRACT

As you are aware, Iran is one of the 10 most vulnerable countries worldwide, suffering yearly heavy material and human losses. Most past earthquakes in Iran have a rural nature, and the damaged and destroyed structures are generally the instruments of the floors made of clay, stone, and brick, and in terms of residence, they were single-family. After the occurrence of these earthquakes, rescue operations are carried out by self-help and with essential equipment such as shovels and pickaxes. There is rarely a need for complex search operations with the help of advanced mechanical equipment. Unfortunately, currently, in the event of an earthquake in Each of the big earthquake-prone cities of Iran, for example, Tehran, Tabriz, and Mashhad, due to the seismic vulnerability of their building structures, the dimensions of very extensive structural damage and the number of people trapped in the debris created, will be huge, so the importance of identifying the typology It pays more attention to vulnerable structures in urban and rural areas. By identifying vulnerable structures and destroying and rebuilding them, it is possible to reduce the burden of human disasters to a great extent

Introduction

The title of the research is identifying and typology vulnerable structures in urban and rural areas against earthquakes. In detail and more precisely, it means the statement of the limited shortcomings studied against earthquakes, the solutions of compiling basic measures to reach a correct and resistant model against earthquakes, and examining this issue in three periods before, during, and after the accident.

Importance and Necessity of Research

In our country, no special attention is paid to construction principles. Everyone with any taste and education builds a house, the result of which is non-resistant and non-standard houses that threaten the lives of innocent people every

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moment. In this research, we have tried to identify the typology of vulnerable structures in urban and primarily rural areas so that maybe by reading this material, we can think a little about why this vital thing is one of our most basic needs [1-3]. We have not paid more attention, and maybe we can draw the attention of the relevant officials to the importance of construction and drafting principles and rules to improve houses [4-6].

Research Objectives

1- Getting to know the context of the village and the city

2- Familiarity with building materials

3- Familiarity with brick, metal, and concrete structures

4- Investigating the vulnerability of rural and urban structures

5- Providing ways of strengthening

6- Providing basic solutions to deal with risk

7- Examining the stages before, during, and after the crisis.

Literature and Research Background

The research on the strengthening of structures and the identification of the typology of vulnerable structures in Iran can be attributed to the time of the creation of civil engineering disciplines in Iran. But seriously, after the 1369 Rudbar and Manjil earthquake, much research has been conducted in this field, most of which is related to the Housing and Urban Development Research Center. Of course, after the Bam earthquake, which left a lot of financial and human losses, a few officials forced the movement to strengthen vulnerable structures. This is while Japan started measures to strengthen structures 50 years ago. It has reached a point where there is no damage at all, or the amount of this damage is minimal [7-9].

Statistical Society

In this research, all the cities and villages of Iran have been briefly discussed and analyzed, and the general conditions of the cities and villages are considered [10-13].

Figure 1: Iran Map

Research Method

Most of the materials and information in this research were in the form of a library and through documents and records. In some cases, it was in the form of field observation of several cities and villages [14-16].

Analysis of Research Findings

The research title is "identification and typology of vulnerable structures in urban and rural areas against earthquakes". But why against an earthquake? The occurrence of an earthquake has a more incredible spiritual and

psychological effect on society than other factors, and the reason for the intensification of the spiritual and psychological effect of an earthquake is due to:

1- A sudden earthquake

2- Unpredictability and surprise

3- Very deadly destructive effects

4- Huge loss of life and money [17].

5- Creating a crisis in society

First, we should know what an earthquake is and how it affects buildings [18-20].

Earthquake

The energy released due to various factors (movement of the earth's crust) of volcanoes causes large masses of rocks to slide along the fault plane.

Figure 2: Earthquake

General Effects of Earthquakes

Direct movements of structures: Direct movements of structures is a movement that is obtained directly by connecting the structure to the ground. The two main effects of this movement are an instability effect caused by shaking and an instability effect due to the inertial force that causes the structure. It counters the created movement.

Earth's surface faults: These may include cracks, vertical movements, total settlement of an area, and ground movements.

Root and tidal waves: The earth's movements can create huge waves on the surface of the seas, which can also cause significant damage to coastal areas.

Flooding, fire, gas explosion: Faults with earth movements may cause damage to water dams, water reservoirs, river banks, and pipelines, which may cause various types of accidents.

How do Earthquakes Affect Buildings?

When an earthquake occurs, the earth shakes and moves back and forth suddenly and quickly. This movement may be in any direction. An up and down movement, especially in the vicinity of Mer.

There is an earthquake. The foundation of the building moves with the ground. However, the inertia of the rest of the building causes a slight delay in moving the higher parts of the building. These delays in Turkish buildings are a clear example of earthquake damage. The force that an earthquake exerts on a building depends on the ground's movement and the building's weight. The heavier the building, the greater the force, which is why lightweight buildings with incredibly light roofs are desirable in earthquake-prone areas. Buildings that are not designed to withstand the force of an earthquake are damaged to different degrees due to an earthquake.

Factors Aggravating Building Vulnerability

1- The heavy weight of the building (concrete)

2- Low resistance of materials against stretching and cutting

3- Weakness or sometimes lack of building executive connections

4- Poor quality of building execution

5- The creation of fatigue and, as a result, the loss of resistance with the passage of time and the prolongation of earthquake fluctuations, "fatigue caused by loading and unloading."

Studying the External Texture of Village and City

Many factors affect the external texture of the village and city. One of the most important factors is the natural environment, which includes climate and geographical conditions, for example, mountains, rivers, pastures, and springs. In terms of climate, for example, the outer texture of Yazd city, which is located in a hot and dry region, is very different from Kurdistan, which is in the highlands, or in terms of the geographical situation, for example, a village located in the middle of two mountain ranges may have a linear shape. A village in The located plain can be formed in regular and irregular forms to different extents.

Dispersion and Density of Rural and Urban Units

Dispersion in cities is primarily due to more accessible access to commercial centers, service centers, and communication guides; that is, wherever these facilities are, the density is more significant in that area, and the more facilities and resources are in one part of the city, the more dispersion is in the same area. It will be less and denser. But in villages, the dispersion of the village can be along the communication road, or in good weather conditions, the dispersion is more. For example, villages are more scattered in the country's north than in desert and dry areas.

Investigating Effect of Social Relations in Context of Village and City

As you know, our villages have three constructions: Ili, Dehghani, and Ili-Dehghani. Villages that have Ili construction. Like a nomadic state, they spend every season in one village, and these villages become empty of inhabitants in winter, for example. The villages with a peasant structure have a long history. The villages that have an Ili-peasant structure are the villages that belong to the Ili group. Due to various reasons, they lost their original status or were forced to relocate. Each of these villages has its texture. There is a significant difference between authentic cities with a long history of urbanization and less immigration and cities with a lot of immigration and a considerable number of people with different cultures entering it at any moment.

Physical Study of Village and City Context

In the physical study, we deal with two topics: the form of the collection and the elements of the collection and their relationship. Regarding the shape of the collection, it can be stated from the study of the views and sections of the sampled collections that:

- The villages do not have a unique variety in appearance. The uniformity and simplicity of their facades and sections are influenced by the simplicity of rural society and its manifestations. In contrast, the facades and sections have a lot of variety in the cities.
- Social factors and natural conditions also influence the shape of the plans. Collection elements

Including 1: Buildings that may be residential or service or mixed 2- Passages that include roads, alleys, and public open spaces. In the village, the establishment of buildings is not subject to a particular rule or law, and the complex elements are almost not worth comparing to each other. Still, in the cities, the buildings must be based on the planning and permission of the municipalities. Of course, in many cases, the necessary control is not done in this field.

Acquaintance with Urban and Rural Structures

Most of the rural structures in Iran, due to the lack of attention of the officials, the lack of safe building culture, and the lack of financial ability of the people, are mostly made of clay and clay or very old building materials. Adobe buildings are easily damaged by 4-5 magnitude earthquakes.

In this type of building, all walls bear the load. The walls are very thick, and their diameter may reach one meter. Every year, the roof is plastered to prevent destruction of the roof.

The lack of compliance, the lack of appropriateness of the height of the wall with the width of the corridor, "narrow alleys", the

lack of proper communication routes with the outside of the village, the lack of a relief network, in addition to the lack of status of rural houses at the time of the accident, adds to the deterioration of the situation. In our cities, various structures can be found. However, most buildings are made of metal or concrete. However, in the outskirts of cities or poor neighborhoods, there are still structures made of brick or clay, which will be very vulnerable during an earthquake. The decay and age of the buildings, the lack of resistance to the effect of the structures, the mismatch of the building's capacity with its use, and the failure to observe the ratio of the height of the wall to the width of the corridor, the lack of training and familiarity of the people to deal with earthquakes, the lack of escape routes, the lack of a headquarters for forecasting, coping, organizing, lack of access to relief resources, medicine, lack of debris removal and special relief equipment, lack of essential planning and lack of participation and coordination of other organizations can significantly increase the damage caused by the earthquake.

Brick Structures

For Zal areas: Zale Khair 3 and 4 uses reinforced brick structures. In such structures, brick walls are made of hollow blocks. In this way, hollow concrete blocks are reinforced to each other by rebar. Reinforced concrete brick walls can absorb mobile shear force. The things that can be discussed in such walls are as follows:

The presence of small cracks on the surface of reinforced concrete structures can be due to concrete shrinkage, changes in ambient temperature and concrete expansion, settlement of supports, and tensile force inside the concrete.

In addition, where the concrete is implemented in two stages, there are unavoidable cracks. During an earthquake, the amount and depth of the cracks increase, and the cracks appear in the form of a network.

These network cracks may increase or decrease the strength of the structure. If the number of reinforcements is enough, a structure may remain due to the cracks.

Metal Structures

Many ferrous and non-ferrous metal alloys are used in buildings, but iron, steel, aluminum, copper, lead, and zinc are more dominant. The new approach in construction is towards more durable alloys and coatings to create protection and appearance diversity in all kinds of products. Steel is one of the earthquake-resistant building materials with high formability and strength-to-weight ratio. The behaviors of steel structures in past earthquakes have been good. Even though structural steel is formed from a malleable material, mainly due to local instability and cracks, they do not always behave smoothly.

Steel structures show the following types of damage due to earthquakes:

A) Brittle failure of screws and rivets in tensile shear

b) Brittle fracture of corner welds in shear or tension

c) Lifting the wind-sealed frames

d) slippage of screws and rivets

e) Changing the place a lot in non-windproof frames

f) Breaking connections between steel members and other building members, such as floors.

Steel and Reinforced Concrete Composite Structures

These structures have characteristics intermediate between steel structures and reinforced concrete structures. In Japan, it is often used for medium to high-rise buildings. In the Kanshu earthquake (1923), high-rise buildings with composite construction showed an excellent capacity against the earthquake compared to ordinary reinforced concrete structures. The bending behavior of a member until the maximum strength is achieved is similar to the behavior of a reinforced concrete member. However, its formability is more

because after the concrete's corrosion, provided that the width to the thickness of the steel plates is small enough, the steel can withstand more forces, but in terms of shear resistance. A sheathed member with whole steel life will exhibit ductile behavior even if it is broken by shearing.

Even if the steel columns are broken due to cutting, they will show formability behavior.

Steel tubular columns filled with concrete under bending are deformable because the steel encloses the concrete. In addition, the strength and formability of this system will rarely be affected by even relatively large shear forces.

Reinforced Concrete Structures

In many earthquakes in different regions of the world, it was observed that the behavior of reinforced concrete structures against earthquakes is much better than that of masonry structures. Since these structures are economical, they are built in earthquake-prone areas. While the damage caused by the earthquake has been reduced due to the amendment of the earthquake design code, still the following factors that point out the defects affected by the construction and assembly should be considered as the potential for causing damage.

1. Low shear resistance of the floor is obtained due to the small number of columns and walls.
2. Brittle shear failure of columns and beams
3. Twisting resulting from the non-compliance of the center of weight and the center of stiffness of the floor plan
4. Separation of secondary members, such as external walls due to weak connections

In addition to the cast-in-situ integrated concrete structures discussed above, there are also "cast-in-situ or prefabricated" precast concrete and prestressed concrete structures. The connections of a prefabricated concrete structure are made at the construction site; therefore, the earthquake resistance of these structures may be weaker than the one-piece reinforced concrete structures.

Resilience goals

The idea of retrofitting is used for buildings that currently exist and have been designed. The retrofitting steps as described below must be observed:

1. Increasing the strength of structural members by strengthening the section to increase the bending, compressive, and shear resistance
2. Revision of the entire structural system or according to the incoming loads, for example, to place the columns in a line to create a complete frame.
3. Improving the beam-to-column connection for the best transfer of force between members
4. Adding secondary members, for example, adding a shear wall or windbreak

Predictable Vulnerabilities

The amount of damage to buildings depends on the following conditions.

1. The construction method and useful life of the building
2. The area where the building is built. This issue depends on the risk analysis of the area, based on which it can be determined for the desired building.
3. Types of materials, rusted iron, rotten wooden beams, brick materials, or cracked concrete are among the factors that damage the structure.
4. Identifying the effects of an earthquake on similar buildings, and having the same useful life in the target area, is one of the most effective methods for identifying the possibility of damage to buildings.

Seismic Strengthening of Structures with Building Materials

Several methods are used to restore and retrofit buildings with brick and stone materials. Masonry buildings, including load-bearing wall systems and damage to Ler A string, is inserted into them in one of the following ways. The lack of strength and rigidity of the roof and floor diaphragm, the absence of belt floats or reinforced concrete tensile beams, and the absence of tensile beams between the external walls and the roof and floor system, which in this case collapses at an angle of 90 degrees to its plane. Also, the lack of sufficient strength and instability of the wall, in the case of structures with stone materials, instability may occur due to the lack of connection at the intersection of the walls.

Emergency measures may include the preparation of vertical supports or transverse wall braces to prevent wall collapse. Temporary supports may be required for balconies or stiles attached to a damaged wall. Repairing the seams or replacing the intersection of the damaged walls is one of the main parts of the restoration unless the particular strengthening methods can withstand all the loads and forces applied to the wall. In general, building retrofitting plans with building materials should provide the strength and connection of the roof and floor diaphragms to the walls to resist earthquakes.

If there is an apparent weakness in the whole structure, not only should they strengthen the damaged parts, or they may add new anchors, or if necessary, the parts damaged in the earthquake should be destroyed and reconstructed.

Rehabilitating Buildings Against Earthquakes

Resilience methods: This part explains the common standard methods of retrofitting existing buildings. Building retrofitting may include strengthening damaged parts or removing damaged members and replacing them with new and strong members.

- It is easier to use this method for steel buildings compared to concrete buildings. Sometimes the skeleton of the building may be strengthened to improve the lateral resistance system. Another example is suitable materials for covering wooden frames to increase their lateral strength.
- Thickening, enlarging, or strengthening the organs
- Adding shear walls, vertical braces, and new columns to the structure. Sometimes the building may resist gravity forces and be weak against lateral forces. In this case, this weakness is eliminated by adding lateral braces, for example, in the central core of the building. This strengthening method is suitable for historical buildings whose exterior does not suffer damage.
- Repairing shear connections to clamped connections
- Reducing the mass of the building by removing the upper floor
- Investigating the dynamic characteristics of the "reinforced" repair structure

Critics

- Lack of strict and principled supervision of the construction method in cities and especially in villages
- Absence of a responsible organization in rural construction
- A fundamental encounter with immigrants from the village to the city and the creation of shantytowns and slums around the cities
- Lack of necessary credits for low-income groups in the direction of resistant construction
- Officials' lack of attention to building culture in the direction of resistant construction
- Absence of necessary rescue facilities and equipment in emergencies
- Lack of coordination between different organizations and bodies

Suggestions

- Legal approval for the reconstruction of rural houses and non-resistant urban buildings
- Creating facilities for people to rebuild vulnerable houses
- Applying incentive methods to attract people's opinions on the matter of rebuilding vulnerable houses
- Cultivation and education of people
- Building insurance
- ۱-Establishment of crisis management headquarters
- Crisis management cycle
- In the discussion of crisis management, we have four stages:

1-Prevention

2-Preparation

3-Combat

4-Reconstruction, which will be explained in the following about each stage.

Prevention Stage

At this stage, by taking the following measures, the financial and human losses caused by the earthquake can be reduced to a large extent.

- Strengthening the structure
- Strengthening the surrounding facilities and substructure soil
- Conducting a soil test to check soil resistance
- Geological studies to prevent landslides and landslides
- Checking the drainage of the area
- Considering a limited return period for a region
- Historical evaluation of the region in terms of occurrence of incidents and accidents
- Precision in the design and relationships governing it

Preparation Stage

This stage is divided into 3 stages: a) preparing for the risk b) mitigating the risk c) preventing the risk; the explanations of each stage are given below.

A) Preparedness Against the Danger of Preparedness

1-Creation of crisis management headquarters at the regional level

2- Preparing the map and plan of each building and placing it in the accessible place

3- Installation of signboards to identify the fire hospital and police exits

4- Planning and establishment of forecasting and warning facilities

5- Generalization and description of the duties of disaster response committees

6-Training and conducting maneuvers at the regional level

7- Creation of food and relief warehouses

8- Creation of a warehouse for heavy and semi-heavy equipment for aid and rescue posts and debris removal

9- Census of the population of the target area and registration of the characteristics of each person in the computer

10- Determining temporary accommodation places

b) Mitigation Risk Mitigation

1- Creating an open space for stopping points

2- Changing the use of buildings

3- Widening the streets and alleys

4- Lack of concentration of relief and food stores in one place

5-Strengthening infrastructures such as the safety of water, electricity, gas, and telecommunication lines.

Figure 3: Mitigation risk mitigation

Conclusion

In this research, firstly, materials were presented about this issue's objectives and importance. The study of the earthquake, its destructive effects, the example of the effect on the buildings, the examination of the external texture, and the density of the physical studies of the villages and cities were discussed. In the next stage, types of structures and typology of urban and rural structures, objectives of retrofitting, masonry structures, methods, retrofitting criticisms, and proposals of the crisis management cycle were discussed. The point to be pondered is that with accurate knowledge of the performance of structures and their components against earthquakes, how villages and cities are formed, and the factors involved in construction, we reach a general knowledge. And this knowledge will help us a lot in strengthening the structures and reducing financial and life losses and losses. In the crisis management cycle, we will have a general and more scientific view concerning accidents and incidents. Hoping for a day when the culture of safe construction is considered one of the essential elements of our daily life, and we all strive to have a healthy society.

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