



## Urban Planning Methods in Decreasing Damages of Earthquakes in Distressed Area of the Cities

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### Abstract

The city contains several elements that are organized through urban design and planning takes places. damages of city and especially distressed area due to structural weakness and inefficiency of urban planning in earthquake as a global issue facing professionals in various fields such as urban development is located. Much of the damage caused by the earthquake can due to the high connection of population and density of settlement and urban development regulations are violation while earthquake in the short time physical damages appears in a various shapes so this actions causes physical financial revenue social and economic damages and also it causes urban system be disablement that in this field urban development and urban planning can be include as a efficient levels of planning for decreasing the damages opposite earthquakes and lean on social economic physical conditions as a suitable tools for improvement the environment will be analyses. This article contain study of basic theoretical methods and tools of research and presentation of finding research about weighing damages of urban district from probably earthquakes. The thing in this article which is important is that using tools and methods of urban planning and capacity of this science for decreases the damages from earthquakes in distressed area of the cities.

**Key words:** Urban Planning, Distressed Area, Earthquakes

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### 1. Introduction

Earthquake is a natural phenomenon; it's one of factors for unpredictable events in societies. During past century more than one thousand disastrous earthquakes happened in seventy countries around the world and 1.53 million people died and it caused so much loss of property [1].

However, these recent earthquakes caused many casualties in urban centers and 80% of losses and deaths had happened in six countries include China, Iran, Peru former Soviet Union, Guatemala, and Turkey [2].

Fast growth of urban regions makes these crises more painful and increases their number. Iran's location in region with high possibility of earthquake in the world and having high population density makes Iran a country which is severely vulnerable against earthquake. Iran locates in Alp- Himalaya earthquake belt and it is experience an earthquake 6-7 in Richter once in 5 years.

Irregular population increase, urban built and it's development to outskirts of the towns without suitable planning and including necessary arrangements and regulations caused to multiply gravity of condition.

Way of responding to natural disasters and solving the crisis which caused by events have a direct relation with level of development and achievements of each country. It means that more investment on developing and improving infrastructures of country in order to reduce casualties will have faced negative effects of events and crisis with significant reduction [3].

However, around 50% of Iran's population lives in cities and around 60% of Iranians live in old urban texture and due to this fact the possibility of crisis in Iran makes an irretrievable disaster.

In order to reduce risk of earthquake in cities, it is necessary to do more studies and comprehensive researches about knowing effects of earthquake in urban levels and distinguish the most dangerous regions. Planning to reduce earthquake casualties in high risk regions could decrease earthquake casualties and risks by reducing vulnerability of cities.

This study have investigated on vulnerability of Zanjan city according to factors such as open spaces, population density, building density, age and model of buildings and the extent of blocks and finally have been explored plan of vulnerability. These indexes selected regarding to the limited feature of studied region and kind of its available data.

## **2. Crisis and its Kinds**

Crisis is an accident which happens suddenly as a result of natural and humanistic events and functions. It imposes difficulty, adversity and casualties to a set or society and removing this problem needs extraordinary and emergency actions and performances [4].

According to UN international strategic program for reducing disasters, all accidents have two sources:

A: Natural disasters

B: Disasters caused by technology (Human made) [5].

Unexpected and destructive events such as «earthquake, flood, tornado and so on» which threaten so many lives is classified as «natural disasters»

## **3. Earthquake and its Effects**

Everything is changing around us and we are satisfy with living on earth. We indebted our sustainability to the ground, but sometimes, ground move suddenly and it is earthquake e.g. an event that happen without alarm. It can be said that earthquake is the most frightened and fatal natural disaster because it start suddenly and there isn't time to escape [6].

Earth's shaking is called earthquake which usually happened due to making pressures on earth and caused earth to crack [7].

Therefore, earthquake in its common meaning caused by movements of the earth's crust on to mantle which compressed its crust in some regions and then energy released by sliding, some earth's fissures, either in depth of seas or on lands, and then earthquake happens [8].

According to another description, earthquake includes moving and severe trembling of parts of earth's crust together with all materials and buildings on that part due to fold movements, volcano and/or available tensions on earth's crust [9].

Earthquake makes different effects on it's surrounded environment as a natural factor. In cities as a system, these effects can be classified in two classes of direct and indirect effects, as following:

A: Direct effects of earthquake: effects that happen directly and without mediator because of earthquake and caused different damages and casualties in cities, they are called direct effects of earthquake.

B: Indirect effects of earthquake: Effects that made as a result of direct effects are called indirect effects of earthquake including:

- Economical effects of earthquake
- Social effects of earthquake
- Managing effects of earthquake
- Environmental effects of earthquake
- Physical effects of earthquake

#### **4. Crisis Management Resulted From Earthquake**

Crisis management is a practical science which use systematic study of crisis and analyze them in order to search for a device by which prevent crisis and if crisis happened, it can reduce their effects, make necessary preparation, fast aid and improving situation [10].

Crisis management referred to actions which have been done before occurrence, while occurrence and after occurrence of accident in order to reduce most of its bad effects and problems [11]. Also, crisis management is described as planning, organizing, leading, arranging, controlling and supporting[12].

One of the main duties of crisis management reduces bad effects of crisis, readiness and improves condition before occurrence [13].

Some related concepts of crisis management will be studied in the following in order to more investigation.

##### **1.4. Description of Critical Condition**

The condition in which all common activities in a society stop that may caused so many deaths and financial losses and environmental problems, it is called critical condition [14].

##### **2.4. Description of Accident**

Accident includes a rare or exceptional case in nature or human made environments which may have negative effects in people's life, property and their activities in past and sometimes leads crisis [15].

##### **3.4. Description of Vulnerability**

The level of sensitivity in a society against accidents and events on one hand and the big scale of its damages and losses during occurrence on the other hand, are called vulnerability.

Urban vulnerability: The degree of capacity differences in urban societies in order to campaign against effects of natural happenings according to their situation in real world (spatial structure of cities) and social features of those societies (social structure of city) [16].

Social vulnerability: social vulnerability is the result and creation of structural relations in groups and forces of society against different natural pressures and abilities and capacities of society and people for responding and reacting to natural events [17].

#### 4.4. Description of High Risk

Places and regions which have possibility of incident occurrence in a special time period are called high risk regions. Assigning high risk regions is done according to zoning maps of vibrations in an earthquake. High risk regions are classifying based on seismicity of regions according to basic acceleration of design and also risk possibility and seismicity as following.

Region	Description	Ration of basic acceleration of design
1	A zone with very much relative risk	0.35
2	A zone with high relative risk	0.30
3	A zone with medium relative risk	0.25
4	A zone with little relative risk	0.20

**Table 1.** ratio of basic acceleration of design in regions with different seismicity

#### 5. View Point and theoretical Basics Related to Crisis Management

Cities are dynamic systems and results of humanistic relations and natural environment during years and need balance to maintain, evolution and development.

Any imbalance in urban system (it means urban spaces and textures) and out of urban systems (it means spaces around and near regions and cities) leads to instability and disorder. Imbalance occurs when internal and external urban systems face sudden and unexpected changes without any planning.

From crisis management point of view, effective systems in urban life can be classified in two types:

1- harmful systems and

2- Impressionable systems[18].

These are natural and humanistic processes which can have disastrous effects. They include earthquake, tornado, bomb attack, and permeate atomic bombs.

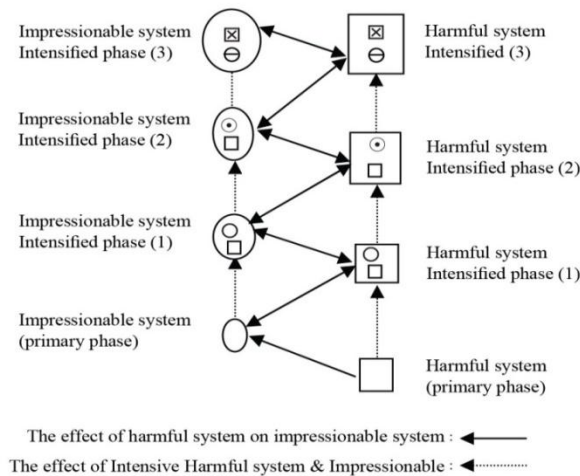
Harmful systems mean any artificial device and instrument that is necessary for human beings and humanistic society and it may affect by its ultimate reaction with harmful system [19].

The results of research on disaster show that always there are mixtures between disastrous events and their damages. These mixtures referred to relations between them and usually, when accident change to disaster, other fields, factors and natural and humanistic processes could have affected them.

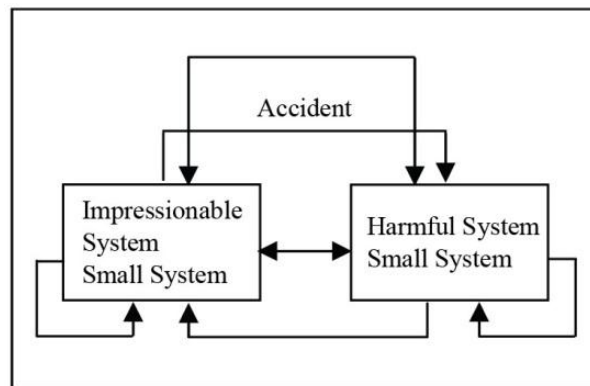
So, forms which may occur in an impressionable system ( means amount, type and damage circumstances) is a sub set that is function of main set i.e. harmful system, for example, soil liquescence can intensify earthquake damages, while rain is effective in extinguish fires.

This way, impressionable systems may activate harmful systems. For instance, inappropriate hygiene condition caused plague and so impressionable system itself changes to harmful system or stop harmful system.

Contrivances in prone to flooding regions which prevent from flooding and making more damages are in this category. So, impressionable system affect on itself, in a way that maintain present statue or return to common condition or intensify damages [20].



**Figure 2.** Mutual, complementary and intensifying relations between harmful systems



**Figure 3.** Cities are complicated systems consisting types of harmful and impressionable systems

In another classification and in relation to crisis management, it can be mentioned two other notions:

**A: Notions of behavioral school:**

Behavioral school emphasis on making and intensifying events as a result of non- normative human behaviors (cutting trees, exceeding graze, construction in critical areas and so on). This approach emphasis on active role of technology and science power in order to preventing incidents; but this notion is criticized because of extreme emphasis on role of decision maker and victims and pay attention to wider social fields and economical power.

**B: Structural school notions:**

structural school (1970), have been designed by relation between incidents and underdevelopment and economical dependencies of third world. In fact, there is an idea that

increasing disasters of developing and less developed countries, due to more attention to world's economical affairs, expand capitalism and marginalized poor and oppressed people instead of geophysical events.

As a result, fans of this viewpoint prefer to discuss about the reality of natural events- what they categorize in geophysical issues- and economical, social and political development of less developed countries in order to achieve clear recognition and distinguish matter [21].

## **6. Planning to Reduce Earthquake Damage and its Stages**

Planning is an activity which conduct a system toward coordinate purposes that related to social worthiness system by administer and control it. In systematic view, the science of administer and control systems in order to improve human's life is called science of planning.

The purpose of this planning is reduce unfavorable effects and disadvantages of earthquake and in most cases its related actions was done with lower costs.

Urban system like all other systems can continue to move dynamically in general condition in framework of favorable planning, but happening earthquake as a crisis will mean disorder during life of this system.

Therefore, by suitable planning in the course of reduce destructive effects of earthquake can act to conform urban system to future crisis and pass critical condition. Planning to reduce damages of earthquake has been classified according to damages:

- Reduce physical vulnerability
- Reduce social vulnerability
- Reduce economical vulnerability
- Reduce environmental vulnerability

In high earthquake risk zoning regions, reducing physical and body vulnerability could be achieved to environmental, social and economical vulnerability reduction. Hence, planning in order to reduce social, economical and environmental damages has been thought as a subdivision of construction and body vulnerability reduction [22].

## **7. Reduce Urban Vulnerability**

Urban vulnerability against natural disasters such as earthquake is a function of humanistic behavior which shows the degree of impressionable with the resistible ability of economical, social units and physical urban properties against natural risks [23]. Vulnerability consists of the possibility when people are exposed to unfavorable effects of an event; in fact, this possibility is a transaction between spatial risks and social forms of societies [24].

Although, earthquake is one of the most complicated natural phenomenon and in recent years, it was subject to discuss while gaining knowledge about field of earthquake and the reasons of its occurrence, but still it is impossible to predict the exact time of earthquake.

For this reason, the vulnerability of human and his living place must be reduced by measured actions and think about suitable artifices and make the ways of confronting earthquake comprehensive in different levels of society.

Therefore, the way of reducing damages caused by earthquake always had been included in research activities of human beings. As, these researches mostly had done about ways of construction in order to determine standards for roof, walls, foundation, exterior, kind of materials and ... to increase building resistance against earthquake, but in studies, earthquake referred to as something more than buildings but as part of biological unit. In fact, the city could have designed by the purpose of reduce vulnerability against earthquake [25].

## 8. The Role of Planning in Crisis Management Process

Effect and role of planning in crisis management process consists of four stages as:

**The moment of occurrence:** This cycle begin with critical condition and by happening earthquake which will have made very extent disasters in a very short time, and it may lasts several years to reconstruct its damages, and left deaths, body damages and functional disorder and due to several facts:

The place of establishing houses in seismic lands or unsustainable acceleration and...

- Characteristics of urban framework (physical structure and city texture)
- Characteristics of structure and vulnerability of buildings because of neighboring with each other and with dangerous uses in cities
- Control city development in point of building density and population
- Arrange future developments
- Find places of dangerous activities
- Artifices of city framework include: design suitable city network according to the degree of its limitless
- Try not to centered all activities in one place
- Design suitable texture regarding pattern and size of land divisions about the land be full or empty
- The neighboring of buildings and roads (the ratio of width to body)

**Escape and refuge:** the second stage after earthquake happening is escape and refuge stage and in this stage body and functional characteristics and also humanistic behaviors are very effective in intensifying the crisis. In this stage, body damages are followed and caused by damage to facilities such as gas (firing).

Water (flood) and because loophole passes across building to yard and then end to alley and street or the main open space inside texture, therefore obstruct loopholes and/ or destroy open spaces will make the escape more difficult.

So, loophole and possibility of escape must design in urban texture, in other word neighboring units should have several secure loopholes regarding level of their surrounds.

- Predict enough open spaces with suitable distances from residential textures or buildings with general uses and crowded centers. (The uses which have suitable open space can also be discussed)
- High density centers are easy to access and have enough grounds and correct ways have been determined by guiding signs.

**Rescue performance and aid:** in aid step too, compressed texture and population density, the uses placed in different city surroundings, the establishing place and pattern of distribute interconnected centers and main connect roads in city play the main role.

**Temporary occupation:** In relation to temporary occupation, if the design of land and building statue on land be in a way that even after destruction still enough open space remain, it will reinforce the possibility to establish scattered pattern, but regarding to rubble and demolition, however need to camping, availability of suitable open space is necessary.

## 9. Factors Which are Effective in Vulnerability of Urban Settlements Against Earthquake

The most important factors in field of urban settlement vulnerability against earthquake include kind of materials, age of building, number of floors, kind of uses, level of free space, quality of buildings, land measures, population and width of passages.

### **1.9. Vulnerability Due to Materials**

Generally, buildings made of mud and adobe, adobe and wood, brick and wood and all of wood are completely low resistance and their vulnerability is high and on the other hand metallic and concrete buildings have the least vulnerability because of high resistance materials.

### **2.9. Vulnerability Due to Old Age Building**

Generally, old age reduce the quality of building and therefore building will be more vulnerable. While mean of building life expectancy is 30 years in Iran, buildings which are older than 50 years are worn and they are in high level of vulnerability.

### **3.9. Vulnerability Due to Building Quality**

Building quality is also another important factor of vulnerability, if building is new so its vulnerability is low but old and destructed buildings have high level of vulnerability.

### **4.9. Vulnerability Due to Population Density**

Population density is one of effective factors of vulnerability. More population density limit aids when earthquake occurrence, because population increase caused to slower traffic and transformation. High population density has more vulnerability in comparison with low population density. In fact, high population density will result high construction density, shortage of enough open spaces. So, it can be said that in similar condition, high density area will experience more vulnerability. Crowdedness and rush will result to obstruct and difficult escape and refuge, aid and so on condition which all of them are consequences of so much population density while earthquake occur.

## **10. Urbanization and Problems of Iran's Cities Against Earthquake**

In urban design, the goal is making decisions about qualitative characteristics of urban body factors such as buildings, open spaces and other elements of urban spaces. Body characteristics can be mentioned as amount of mass, manner and place of settlement, size and external shape of each urban factor which can have significant effect on seismic vulnerability [26]. On the other hand, the placement of some factors in city width is effective in intensifying critical condition after earthquake and if looking at our buildings more precisely, we can see problems of our cities based on urbanization. These problems include:

### **1.10. In Conformity and Incompatible Combination of Residual Textures:**

The first problem which is more prominent in our cities is inconformed combination of residential and commercial textures; presence of some busy governmental centers among residential textures is a good example of such situation. Another sample is availability of technical workrooms beside houses and even in basement of buildings in which upper floors are residential. The absence of conformed textures, in addition to making noises and bother neighbors, is problematic by estimate level of vulnerability against earthquake and quantity of probable injured people due to earthquake in different hours of day and night and distribution of injured people all over city that is necessary to know in order to help aid actions.



### **2.10. In Conformity of Building Texture With Construction Condition**

Inconformity of building texture with construction condition resulted by issuing construction allowance with different number of floors in different areas of city is caused to disturb uniformity of views in city extent and reduce their beauty.

Furthermore, it caused to disarrangement of the main period of seismicity with kind of soil on that special area for most of buildings, so it means increase level of vulnerability.

Density sale which was done without any attention to having enough capacity in order to accept and settled that special volume of population, especially capacity of passengers is also intensify the problem of disarrangement of population with amount of urban services. Such a condition raises the difficulty of emergency aid after happening earthquake.

### **3.10. In Conformity of Passengers Width With Buildings Density in Different Parts of City**

Inconformity of passenger's width with density and texture of buildings or in another word inappropriate surrounding in pass ways and urban spaces is another factor caused to difficulty or even in some cases unsuccessful of aid actions to many of populated centers.

Locate most of schools at the end of narrow cul-de-sac alleys is one of significant cases in this field. In most of residual regions, central points of neighborhood are access able only by narrow and spiral alleys, if buildings destruct or damage, access to these places is impossible.

### **4.10. Destroy Green Environment and Gardens and Change the to High Density Sets**

This matter caused to reduce quality of biology and destroy environmental resources, also leads to inappropriate distribution of open spaces and move people who injured in earthquake to places far from their houses for temporary settlement and makes serious shortages in some regions. This issue disturbs calmness of earthquake victims who naturally want to settle near their damaged houses and try to meet their houses several times. Moreover, it will arrange the necessity of intra urban trips while transportation network is in critical situation. It is necessary to mention inappropriate distribution of open spaces such as parks, sport centers and open convivial centers.

### **5.10. In Accessibility to Most of Vital Centers Like Some of Hospitals**

The matter of inaccessibility to vital centers such as hospitals is one of problems which results from not paying attention to the place where plan to construct these places and lack of fundamental planning and studies to find the best place for them. Like last problem, this problem too will prolong the time to reach ambulances and firefighters and other emergency cars. In some cases, it may happen because some damaged buildings or materials obstruct roads, streets and alleys.

### **6.10. Locate Most of Vital Centers in Very Dangerous and Risky Zoning According to Seismic Risk Zoning Map**

Locate vital centers in high risky regions is another point which increase the probability of damaging these centers while earthquake. It is clear that even if an important building design and built according to regulations by basic velocity of 0.60 g, if it locates on zoning with the maximum slope of 0.60 g, it surely will vulnerable that building. Locating on slopes which are capable for slip and or near faulting detachment zoning is multiply dangers [27].

**7.10. Locate Most of Key Structures of Vital Arteries, Like Water Reservoir Beside or on Faulting Detachment Zoning**

Locate key structures of vital arteries systems beside or on faulting detachment which its significant sample is city water system reservoir, increase the probability of water outage after earthquake because of severe damage to reservoirs. Furthermore, it suggests the probability of flood. Some bridges and highways are also locate near faulting detachment zoning which increase their loss.

**8.10. In Appropriate Volume of Urban Infrastructure Services With Population Density in Different Areas of City**

Shortage of urban infrastructure include power and gas in some places can also subject to loss of energy and make after earthquake condition more critical and serious.

**9.10. In Effectiveness of Transportation System Especially Urban Transportation**

Ineffectiveness of urban transportation system can clearly stop or face it with so many serious problems after earthquake.

**10.10. Irregular Development**

Development without paying attention to urban capacities and resources and environmental invasion especially higher than 1600 meters, in addition to environmental damages, makes it difficult to service to faraway places and leads to reduce services to other places of city.

**11.10. Physical Development of Urban Places Without Paying Attention to Different Levels of Earthquake Risks**

The subject of urban physical development without paying attention to earthquake dangers have different dimensions. Firstly, this matter cause most of present buildings and facilities in area of faulting detachment be on small and big detachments and if alluvium rapture receive to earth's crust, it will make so many serious problems for structures and facilities. Secondly, because urban development was done without regarding to detailed zoning map and regarding to the fact that maximum slope is locating in some areas of city and soil's main period is different in other urban areas, it is probable that building texture and their density isn't suited with surface and soil's main period, and this matter automatically causes to increase vulnerability [28].

**12.10. Incapability of Vital Centers Including Hospitals, Fire Station and Police Office**

Limited number of health and medical centers, in common condition causes to accumulate appliances to these centers and consume their time. If suppose that these centers don't damage and be safe after earthquake, but this matter makes it difficult to care all appliances and just for this reason so many injured people may dead or be in danger. Limited number of fire stations in common condition causes not to cover all urban points in standard level. In critical condition, if suppose that the buildings of these centers be safe and secure and be able to service, expansion of fire after earthquake which occurred in most of previous earthquakes will result. The problem of transportation due to loss of urban transportation system also intensifies this matter. Lack of police stations also in normal situation leads to insecurities, in critical statue after earthquake surely will result so many social insecurities. By the way, it must be mentioned that many of security centers are in bad condition because of their unsustainable and weak building which can't resist against earthquake [29].

## 11. Conclusion and Summary

Earthquake is not a disaster, but it's our interface and action with it which can make a crisis or disaster, what makes our period a critical period is concentration of capital and human beings in a place called city and this concentration increase expansion and intensity of earthquake damages. But reduction of intensity and expansion of domains of earthquake damages in city is not only possible with constructing good and sustainable buildings. Because as the experience of Kobe earthquake happened in Japan in February 1995 showed that other than sustainable buildings, earthquake can make so many losses in city and its reason in Kobe was damaged to elements, facilities and urban infrastructures which didn't plan for earthquake. Geographical situation of Iran's cities shows that regarding to their location around main and sub crevasse, it is necessary to make predictions in order to interface with probable earthquakes. And city planners must predict necessary solutions to decrease its effects. On one hand, our country in face with natural disasters passed a clamorous and hard time during passed decades because of not having any planning and necessary actions for interfering natural disasters.

In any point of view, use of urbanism in order to reduce vulnerability against natural disasters is a fact and important and fundamental necessity either in national and international scale. In urban and even rural settlements, the first and most important action for design and organize them is observation of safety instructions related to the place of locating textures and damages due to characteristics of natural location and geographical condition, because it is determining type of proper texture. Then, it must be mentioned to order of all elements and components of texture to increase general utility of texture. Control quality of construction of building units and materials and be sure about correct performance is a hard duty for urban managers and attendants, but forming urban texture can be increased toward safety condition and quality of residual parts of cities by applying regulations. In this way, the guarantee to perform the regulations is higher, it is easy to control and its positive effects will be remaining for a longer period of time. Regarding to above text it can be said that present situation of our cities especially metropolises isn't correspondence with what it must be in urbanism point of view. In order to protect citizen's life and property and reduce earthquake losses especially in metropolises and in one word having a future without accident or with least accident that is the condition for sustainable development. We must refer to urbanism which escape from accident and even interfere with accident.

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