



# Modern Methods in Industrial Production of Construction and their Necessity after the Incident

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**Abstract:** Solving problems such as long time needed for construction, short useful life or high cost of constructing buildings in the housing section requires presentation of strategies in order to practically use the modern construction systems and new building materials in order to reduce weight and time of construction, increase durability and ultimately reducing the time of construction. These attempts, in the long run, will lead to the optimization of construction, increasing production of houses and reaching a desirable executive condition and accelerating the process of construction. This matter will help the government to fulfill its purposes in the housing section. The present research has been conducted for reviewing the necessity of temporary accommodation of the victims in the respect of providing a shelter for the homeless and the quality of temporary accommodation of the victims after the occurrence of crisis. In this respect, the governmental authorities and executors in the countries often face several man-making and non-man-making incidents. Losing one's house due to the occurrence of war, earth-quake and other disasters has always been a social, cultural, economic, political problem and an issue of safety throughout the history and they have shown themselves in different ways. The main weight of these problems has always been on the shoulders of common people, in such way that a majority of people will have to leave their ruined homes due to fear, lack of safety, and lack of a good program for providing proper residencies after the occurrence of the crisis or they settle beside their ruined houses if they feel safe. In addition to providing construction systems and modern methods of construction and also new materials which provide the necessary conditions for reducing the weight of the buildings and also making them strong against all kinds of forces, this article also provides some recommendations for fulfilling the mentioned purposes as well as developing and improving the technology of building houses in the country

**Keywords:** Industrial Production, Accommodation, Crisis, Preconstruction, Modern technologies

## 1. Introduction

A high percentage of population growth and numerous disasters, which have shown themselves in the form of natural and unnatural disasters such as earth-quakes, flood, war or consequences of inaccurate economic policies which lead to immigrations to specific locations, are the reasons for which the problem of shortage of buildings and houses in our country has become a basic and serious problem and the necessity of reviewing this in a scientific, specialized and executive manner has become more significant than ever. Human beings have always struggled with the types of damages and disasters since the beginning of their creation and that is why they have experienced various financial and damages to their lives. No place on this earth can't be named which has not been damaged by various incidents and disasters, that is why various societies have always looked for places where they can control or minimize the damages caused by the incidents in such way and in fact manage the incidents and crises. In this research, crises are divided into two groups:

- 1) Natural crises such as flood, earthquake, volcano, hard storms, avalanches, tornadoes and lightning and etc. that have caused more than 3 millions of people at least throughout the whole world and 800 million others have been damaged in such way.
- 2) Unnatural crises have been made by human beings in a way such as war (throughout the second world war over 400 million people died) among which crises caused by technology, political crises, explosion of chemical industries, air pollution, fires and etc. can be named.

Iran has always been exposed to various natural and unnatural crises throughout the history due to presence of geographical, economic, political, cultural and religious features and natural resources and so on and subsequently, various damages have been imposed on this country and it will face various threats in the future as well. One of the threats we will face can be called war. After the occurrence of war, homelessness of citizens and the quality of accommodation of the victims are among the problems of programming in managing and controlling the crisis which are faced by the governmental authorities and executors of Iran as a result of man-making and non-man-making incidents and disasters. Losing one's house due to the occurrence of war, earth-quake and other disasters has always been a social, cultural, economic, political problem and an issue of safety throughout the history and they have shown themselves in different ways. The main weight of these problems has always been on the shoulders of common people, in such way that a majority of people will have to leave their ruined homes due to fear, lack of safety, and lack of a good program for providing proper residencies after the occurrence of the crisis or they settle beside their ruined houses if they feel safe.

In specialized writings, the following words have usually been used for temporary accommodation.

- a- Transferable residency includes stages of residency from the emergency times to the time of consolidation and "time" factor shall be considered as the main index.
- b- Intermediate residency has a similar meaning as the previous word which includes the process of time and physical shape of temporary residency altogether.
- c- Temporary shelter which completely refers to physical and structural type of temporary accommodation and includes prefabricated temporary structures and forms.

The concept of temporary accommodation has been considered to be a combination of the three items above which include both the physical and nonphysical aspect of the shelter and the residency after the crisis. Therefore, the present research attempts to answer the following questions.

How can the idea of industrial production act as a designing approach?

What advantages can industrial production have?

What are the methods of industrial production of the building?

## **2. Research method**

Reviews of the specialized writings show that the general meaning of temporary residency and shelter exceeds only "living location" and it includes concepts such as living subjects, peace of mind, mental and physical ease, safety and continuation of life. In the mentioned literature, the range of definition of shelter fluctuates from a simple small room built and established by the person alone to permanent accommodation. It shall be known that people become "homeless" after an incident not just "houses". This means that a family finds itself to have find their financial and spiritual saving and existence to be ruined in a blink of an eye due to the occurrence of an incident. Therefore, temporary accommodation and shelter shall be seriously considered as a space for creating peace, safety, peace of mind and mental and spiritual rehabilitation of the damaged person. Since the present research has a theoretical dimension and is mainly based on qualitative discussions, it seems that the analytical method is a useful method for expressing and explaining the assumptions of this research. In other words, explanation and expression of industrial production and its necessity requires recognition of these factors historically and reviewing it. Accordingly, some of the most important definitions of industrial production have been extracted from the public through library studies and parallel to this, its principles and rules have been compared through reviewing the resources. Ultimately, by

referring to the most important presented theories, the most important presented methods have been expressed which can be useful for making the environment delightful and preparing it after the incident.

### **3. Modular and pre-fabricated industry**

The term building industrialization is used for describing and including the concepts of modeling, pre-fabrication and montage and it means spending for equipment, facilities and technology with the purpose of increasing output, reducing manual work and improving quality. Given that designing and constructing house with a high quality in the short-term is important in the world, it is estimated that 200 millions of housing unit shall be built in the world currently and overcoming this shortage at a logical time is not easy. In order to deal with this challenge, innovative and unusual methods of construction of a house are required. Modern methods of construction of a house and installation, using the principles including a computerized integrated production and production (FMS) of flexible production systems (CIM) can create the hope of establishing houses in high power and speed along with innovative ideas. Recent interests in construction is moving towards pre-fabrication more and more and the idea of pre-fabrication is also traced back to the 18<sup>th</sup> century and usage of simple modules was the basis of this work and its basic idea is modularizing the elements that are used less. This method is known as pre-fabricated architecture and was classified in three groups (Eghbali, et al., 2012, p62):

1. (Sectional houses) which are built in the "place of production" of the modularized pieces and with a variety of designs.
2. (Modular houses): completely pre-fabricated pieces are attached together in the "installation place".
3. (Movable houses) such as caravans which have the ability to moving with the residents (same).

The oldest sample of the pre-fabricated houses was in 1624 when one of the wooden panel buildings was used as a fishing house in England. This house was mobile and it could be recollected in the next times. This preliminary experience is one of the preliminary usages of the pre-fabricated houses and it has led to the creation of the contemporary residencies. In the pre-fabrication industry, standardization has the winning card, the process of "standardization" leads to the development of "modular" designing in the house. Development of the ability of being replaced and standardization of pieces was an advance for modular designing in most methods. Modular designing reduces time and the expense of montage to a large extent and it makes making the mass special possible. What is meant by modular designing is a group of products that are similar in the technology, components and combinations. In order to achieve a final unique product by using the small pieces, in modular designing, the production path is uniform in the production lines; in such way that all products pass through a specific and uniform path and the process of production is the same for all similar products and only the two final montages are attached with additional pieces according to the interest of the customers. Some of the basic purposes of using the principles of the system are modular coordination and coordinated size and directing the building towards a series of basic standard sizes (Kharidar, 2011, P40).

### **4. Advantages of modular and pre-fabrication industry**

- 4.1. (For the user) wider application of the product: compliance causes the user to exploit the same system in variable conditions; therefore various systems are replaced by one system. Nonetheless, applications of compliance shall be easily applicable by the user. A compatible system is replaced with a large number of systems in its life and therefore causes a careful usage of capital, storage space, maintenance and installation costs (Olia, et al., 2010, P7).
- 4.2. (For producer) wider application of the design: compliance causes the producer to use the available designing knowledge again and have infrastructures of industrial production (same).
- 4.3. (For the environment) compliance reduces the total rate of production and it instead provides systems which have more efficiency than similar common items. Compensative reactions available in nature for facing the problem of laying off the system includes recycling techniques which are based on redirection of the current of the used systems from garbage masses to the cycle of system's provision. System compliance also has the similar impact because compliance also redirects the laid off system towards a new application (same).

### **5. Accommodation after crisis**

A house is in fact not only a person's shelter against atmospheric factors and their protection against the attacks of other humans and wild animals; but it is also a location for their peace and settlement. As the natural and unnatural disasters occur such as war, earthquake and flood which lead to the destruction and ruining of the house and the peripheral environment of a person's life in general. A person faces some problems from various aspects. One of the problems is losing the shelter and an immediate need for a replacement shelter. Losing the shelter is one of the first problems that occur with this view that the ruined house is not only a potential place for accommodation and protecting a person and family against problems. Thus, solving the issue of homelessness and quality of accommodation of victims is one of the great problems which is crucially important in the stages of facing and encountering after the occurrence of war and in this respect, it shall be responded by considering the type, intensity, time and location of the occurrence of the crisis and the incident. Therefore, shelter is required as a necessary matter for providing safety and achieving peace and ease in the difficult conditions after the crisis and this threat shall turn into an opportunity with an accurate management and programming (Sharifi Rasa, 2012, P4).

## **6. Stages of shelter after the occurrence of the crisis**

In this research, providing a shelter and a residency after the occurrence of the crisis (from the time of occurrence of the crisis to reaching a normal condition) is divided into three stages: a) emergency accommodation, b) temporary accommodation, c) permanent accommodation (Falahi, 2010, P12).

### **6.1. Emergency accommodation**

Emergency accommodation is established in a safe location which is not threatened in a centralized or decentralized manner. The duration of this type of accommodation is 1 and a half month and is usually in temporary tents or governmental, public and personal buildings appropriate for living such as schools, mosques, sport stadiums, offices and military centers and so on can be used. In this respect, after providing an emergency shelter, the rebuilding program of the damaged and threatened areas begin and since a long period of time is usually required from the stage of providing the emergency shelter to creating a permanent shelter and continuation of life in emergency shelter has its own problems for exploiting safety, peace, and living especially in areas with improper weather conditions; thus crisis management attempts to provide temporary accommodation and the site of temporary accommodation is usually designed and implemented as residential complexes and camps. Pre-fabricated places such as developed residential and other materials and industrial structures are created. The duration of temporary accommodation in this research is predicted to be at most one and a half year based on the conditions, type and intensity of crisis and facilities given the technology and industrialization of construction (Falahi, 2010, p14).

### **6.2. Permanent accommodation**

The permanent accommodation stage is the stage of returning to the normal conditions before the occurrence of the incidents where the time of reconstruction finishes, the infrastructures are created and strong and resistant construction units are built which leads to leaving temporary residencies and accommodation in permanent and durable residential units (Sharifi Rasa, 2012, P5).

### **6.3. Temporary accommodation**

As it has been referred to in the mentioned issues, the concept of temporary accommodation can be considered as a series of all of the activities including gathering and identifying the damaged and homeless people, transferring the individuals to shelters and creating a safe, secure, healthy, peaceful living condition until the return to their original place or their preliminary houses (Sharifi Rasa, 2012, P5).

## **7. Criteria of selecting modern technologies**

According to the reviews done in various researches and the reviewed samples in this research, modern technologies are evaluated as proper methods technically for residential buildings if they provide the following items.

- The building and its components shall be designed in such way that they have a proper formation.
- Elements that tolerate vertical loads shall be placed on one another in various floors so that the transmission of the load of these elements to one another would not be done through horizontal elements.

- Elements that tolerate the horizontal forces caused by earthquakes shall be designed in such way that the forces are transferred towards the infrastructure directly and the elements working together are in a vertical plate.
- The building shall be designed in such way that the vertical elements (columns) are ruined later than the horizontal elements (shafts).
- The building plan shall be simple, symmetric in two perpendicular ends without ridges and troughs and creation of asymmetric changes of plan in the height of the building shall also be avoided.
- In order to reduce the torsional forces caused by earthquake, center of mass of each floor to its center of rigidity or their distances in each of the ends of the building shall be less than 5 percent of the dimension of the building in that end.
- Nonstructural pieces and components, especially piece of the façade and its glasses, shall be designed and built in such way that they would not be separated from the structure at the time of earthquake and no financial and physical harm shall be created by their falling down.
- They cannot create an obstacle for the movement of structural components at the time of an earthquake. Otherwise, the interaction of these pieces with structural system shall be considered in construction analysis (Golabchi, 2006, 14).

### 7.1. LSF building system

In some cases, in order to fulfill these needs, using metals as shaped thin sheets, which are called LSF (Light Steel Framing/ Light Gauge Steel Framin) in English, begun in 1950 in common nonresidential buildings in industrial buildings; but since it could not compete with the common construction systems at that time economically, it could not enter the construction industry until 1990. However, since 1990, because of the prices of wood getting higher and environmental problems in construction with traditional methods the LSF construction system (Light Steel Framing) was used for building the residential units by using the CFS metal. Using the LSF system was used since 1990 in America because of being economic with a 300 percent growth per year for building residential units. Japan faced a shortage of residential units of 4.2 millions in 1950. In order for the housing production units of the Japanese government to be activated, the ministry of construction was established in this country. This ministry wanted the constructors to present modern construction designs for providing the required house by considering criteria such as shortening the time of construction, using non-flammable materials and by considering environmental issues and if a design is accepted, they supported it so that it would be possible to use the successful designs in all ways possible. In this respect, using the CFS metal was quickly considered by Japan's construction industry. The cause of success of the LSF system in this country is mostly the specifications of construction in this country. The LSF method has been used in Sweden and South Korea widely since 1996 in addition to the mentioned countries (Golabchi, Mazaherian, 2009, P5).

The galvanized or stainless steel is made out of the CFS metal. The difference between the pieces made out of hot metal in comparison with cold metal is the variety of the formed metal in the cold state compared with hot metal. These pieces are usually called the metal pieces with open or close thin wall. This type of materials is made out of sheets with a thickness of 0.4mm and they provide proper conditions for architectures and engineers for the realization of the designs required by them. Building the roof in the LSF system is done by using the materials shaped as C called Joist. Joists have been composed of trapezoidal metal sheets which are covered with a few centimeters of concrete and the constructed roof acts as a composite slab with the same method. One of the advantages of the LSF system is having the potential of complying the types of common façade constructions in the country. This system provides many capabilities in designing and constructing a house. A variety in shape and size of the CFS pieces provides various facilities for the designers; in such a way that the weight of the building reduces at the time of using proper building materials and leads to the increase of the resistance of the building against earthquake. The LSF system is a building with the capability of producing an industry by using which the building can be constructed without a dependency on the climate. This issue is very significant for constructing a house in Iran due to special climatic conditions especially in winter (research center of construction and housing, 2009, p10).

### 7.2. Thermomur construction system:

This construction system is based on using the pieces made out of polystyrene as hollow blocks and as templates. These pieces are filled with concrete and fittings and it creates an integrated and resistant series. The most important features and advantages of this system which are observed in all of the stages of designing, installing, building and implementing widely are (Golabchi, 2006, P16):

- Increasing the speed of construction
- Easiness of construction
- Reducing the cost of construction
- Creating an integrated and cohesive construction system
- Using energy in the building optimally

The Thermomur system can be used as a proper and desirable system when the speed of implementation, reduction of costs and economic consumption of energy is crucially important. The construction method of this system makes a type of usage of architectural designs and construction shapes (façade and segment) possible. By using this system, there is the possibility of building multiple-floor buildings. Installing mechanical and electrical equipment on this system can be done with simplest tools or even without a skilled worker. The Thermomur system is proper for residential buildings (with one or more families and also residential complexes) and it can be used for educational buildings, hospitals, clinics and hotels. By using the mobile equipment and machineries, it is easily possible to construct pieces and components of this system in the location as well. That is how the cost of carrying the materials is reduced which will be a considerable expense in such method.

The main advantages of this construction system can be expressed as follows (Golabchi and Mazaherian, 2009, p65):

- Possibility of prefabrication of components and pieces of a system in the factory or directly at the location of constructing the building
- Considering the environmental rules, regulations, principles and laws in the process of production and also in the stages of constructing and implementing them
- Possibility of a simple and quick construction of components and pieces in the location without needing heavy machineries
- Flexibility and possibility of providing any kind of architectural design in a desirable manner
- Possibility of creating a bigger and wider pure space in comparison with the implemented systems with common walls
- Creating an integrate, cohesive and homogenous construction system
- Resistance of the building against lateral focuses especially the power of earthquake
- Optimal usage of energy due to high thermal insulation coefficient
- Possibility of saving more than 70% of energy while heating and cooling
- Possibility of installing and establishing the building by the skilled or inexperienced workers
- Reduction of the occurrence of incidents for workers due to the reduction of the weight of materials
- Facilitation of installing secondary pieces such as doors and windows
- Quick and simple execution of telephone and electricity wirings
- Facilitation of execution of cold and hot water pipes and construction utilities system
- Construction speed of more than 4 time of the construction speed with common loading walls system
- Considerable reduction of time and cost of construction (Golabchi, 2006, P16).

## 8. Conclusion

Exploiting scientific methods, modern technologies and new materials is considered as one of the main necessities of qualitative improvement of the housing industry of the country and they are considered as the important requirements post incident. Previous experiences are indicative of the fact that methods such as industrial production of building have been desirable and successful solutions for many societies in emergency cases especially in cases when the reduction of time of construction becomes very significant; although the usage of these solutions in many societies require a special review and attention to technical, executive and economic conditions of that society. Industrial production of building has become a real and important need in

Iran. In order to reach the stage of industrial production, one needs to achieve self-belief in this industry. Seriously supporting the industrial production of building is announced to all executive organizations as an instruction of the government and planning organizations in the country so that it would be used in emergencies both post-incident reconstruction and the housing section. Also, the successful designs which have been finished with the methods of industrial production of building shall be introduced and the architects and engineers of the country shall become familiar with the advantages of this type of buildings; because there is no other way than industrial production in emergencies given the need of housing. Qualitative and quantitative needs of construction over the past decades show that the best strategies of fulfillment of housing purposes in post-incident reconstruction and various classes of society is using modern methods in establishing a building. The need of having a house, in cases where the reduction of the time of construction process becomes very important, has clarified this truth that using traditional methods will not fulfill the purposes of construction. Modern methods which have been mentioned in the construction industry and construction systems which have the possibility of prefabricated industrial production can fulfill the qualitative and quantitative needs. One of the methods of constructing a building is using LSF in the skeleton of the building in which not only there is the possibility of industrial production, but the lightness of the system will lead to the reduction of forces at the time of earthquake and therefore will reduce the vulnerability caused by earthquake. In most cases, solutions which were easier for the public to execute and required no complex equipment, facilities and conditions are considered as more suitable and real solutions. In this respect, reducing the weight of the components of the building, using light materials and using local materials shall be considered especially as solutions which can increase the speed of construction and reduce the cost of building the buildings. Country's planning and management institutions, scientific research centers and relevant organs shall arrange some designing rules, regulations and standards. Developing the building construction methods which lead to the facilitation and improvement of executive operations in addition to compliance with construction regulations and standards are necessary. In other words, what has been considered as the most important policy of the great programs of the country until now is using modern technologies and universal experiences in the field of producing houses with new methods and materials. The systems introduced in this article and more construction systems, which cannot be provided in this article altogether, can be used as proper methods for constructing a building and building a house in the respect of reducing the weight of buildings, increasing stability and reducing the time of construction which have features such as lightness, facilitation of installation, speed of construction, lack of dependence on numerous machineries and equipment, not needing a large number of specialized and skilled human forces.

## 9. Sources

- 1- Eghbali, Rahman; Hesari, Pedram (2012). Modular and prefabrication approach in flexible housing. Quarterly of housing and environment, 143<sup>rd</sup> issue, Tehran.
- 2- Olia, Jalil; Taghdiri, Alireza and Ghanbarzadeh Ghomi, Sara (2010). Structural compliance of industrial systems of construction. Journal of scientific academy of Iran's architecture and urban development, 1<sup>st</sup> issue, Tehran.
- 3- Sharifi Rasayi, Hamid Reza (2012). Designing a post-crisis temporary accommodation with the passive defense perspective. Master's Thesis, Department of Passive Defense, Jame Imam Hossein University, Tehran, Iran.
- 4- Falahi, Alireza (2010). Architecture and temporary residences post incident. Publications of Shahid Beheshti University.
- 5- Kharidar, Fatemeh (2011). Modular designing and quality of products. Monthly of controlling quality, 47<sup>th</sup> issue, Mashhad.
- 6- Golabchi, Mahmood, Mazaherian, Hamed (2009). Modern technologies of construction. Publication of Tehran University, 1<sup>st</sup> edition, Tehran.
- 7- Golabchi, Mahmood (2006). Necessity of using modern construction technologies. Second conference on construction in the Pardis capital of technical department of Tehran University, May, Tehran, Iran.
- 8- Research center of construction and housing (2009). Modern construction technologies. Publications of the ministry of Housing and Urban Development, 1<sup>st</sup> edition, Tehran.