



ORIGINAL ARTICLE

The Design of Residential Complexes to Industrialization

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ABSTRACT

This study focused on housing and its shortage compared to the people needs and expectations. It can be said that today, our country needs not only housing but also safe, cheap and durable housing also, with short construction period. Industrialization of the residential buildings is one of the most suitable solutions to solve the problems of housing in Iran. Achieving this goal is possible based on the emergence of new building technologies and advanced construction methods. Based on the studies and the importance of eliminating the housing problems in Iran and the necessity of paying attention to these items, we considered industrialization approach in architecture design of the residential complex in Tehran suburb. Besides proposing the industrialization system and advanced construction methods in residential complex, we consider the identity, psychological, social and aesthetic issues.

Keywords: Residential complex, Industrialization

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INTRODUCTION

One of the important issues playing important role in people life is housing and its shortage compared to the people needs and expectations. It can be said that today, our country needs not only housing but also safe, cheap and durable housing also, with short construction period. Today, by technical achievements in building sector, achieving such goal is possible. Despite the availability of its technology, this possibility is ignored due to the lack of preparation and our engineers are not aware of it completely. Thus, it is not believed that we can design a building with all the benefits with cheap price [1]. Thus, the speed and reduction of construction cost is closely associated with success in industrialization of building and effect is mutual. Industrialization of the residential buildings is one of the most suitable solutions in solving the problems of housing in our country [2]. Achieving this issue is possible based on the emergence of new building technologies and advanced methods of construction. Based on the importance of eliminating the housing problems in Iran and the necessity of considering the above items, the present study evaluated the building industrialization in housing dimension [3]. There are many ways to solve the problem of housing shortage. The solutions based on traditional view to housing and there is no serious revision in design and its implementation [4]. This attitude cannot solve people problems. The most important issue in elimination of housing problem is changing attitude to the issue and solving it from another aspect. Considering the building and housing industrialization as a national necessity is the change that should be in planning field by which we can use the new methods based on new building technologies. In case of industrialization of construction not only the current demands are met in the society but also it has positive effects in the construction speed, quality and cost of the building. Building industrialization is one of the important factors in increasing production and balance between the supply and demand in the market. The industrialization process of the building controls all the activities of design, technology, construction method and factory production of the building parts and components that is done by observing the scientific regulations and modular and chain standards and observing the cultural, social and economic regulations and sustainable development are done. Industrialization of construction requires progress with all the industries. Here building industry as an old industry with considerable costs of national capital without any considerable progress compared to other industries, need special attention [5]. The industrialization of building is aimed to increase the production speed and increasing the factory productions share and reduction of implementation and change to installation and assembly and the results are making resistant, light weight construction, saving the materials, reduction of energy

consumption during construction, reduction of construction period and reduction of building costs and using the building. This industry should be supported to achieve the following goals:

The effect and importance of building construction are investigated in the following dimensions [6]. The only technical solution for mass production of housing is using industrialization methods of building construction and using various technical techniques and correct management in house construction. Construction industrialization doesn't mean using a new building system and the main aim is reduction of the costs and increasing the speed and easy building operation. This is done by mechanical tools and considerably it is possible via replacing the *In situ* elements with pre-fabricated parts and elimination or reduction of unnecessary details or replacing it with suitable methods [7].

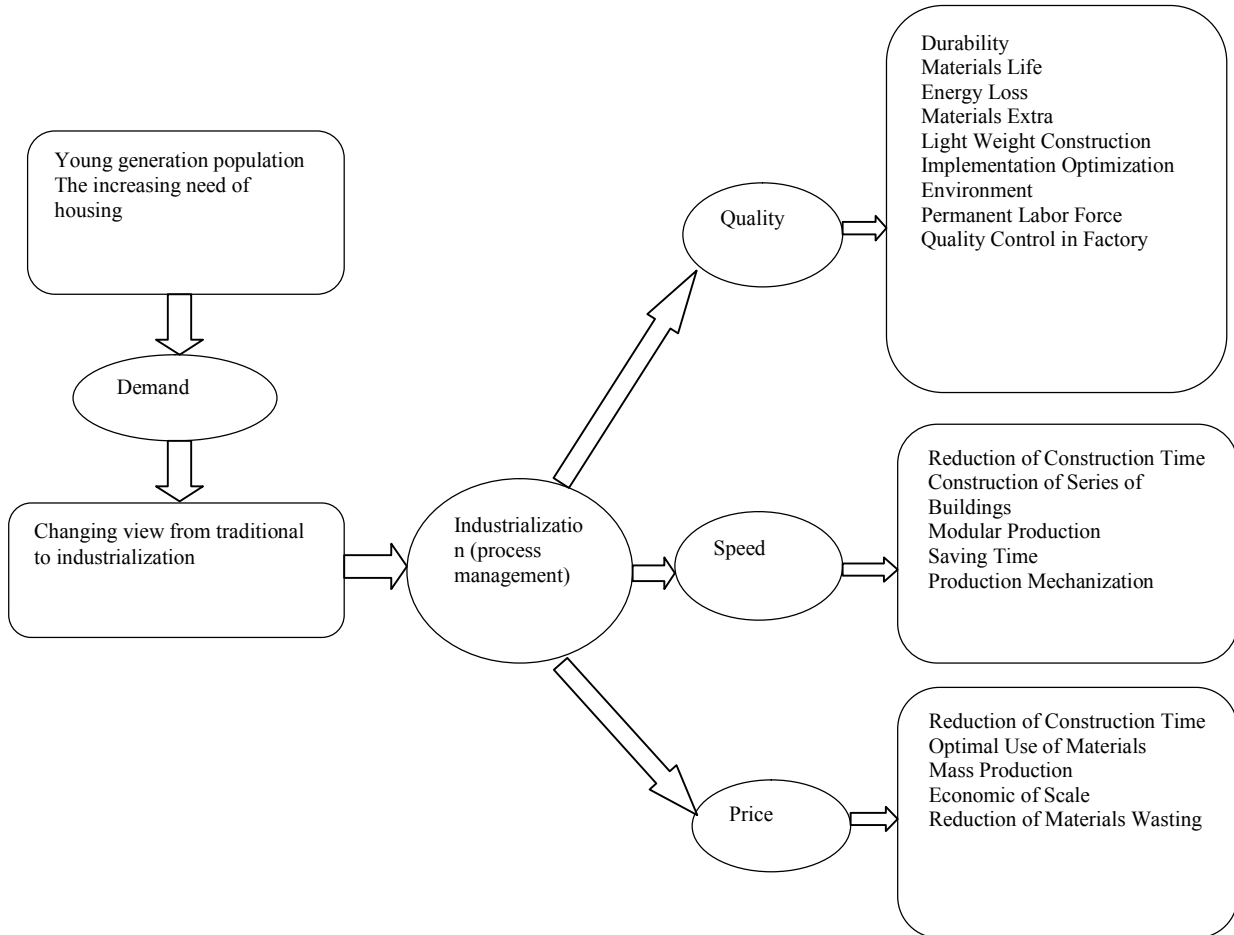


Figure 1- The goals of housing industrialization

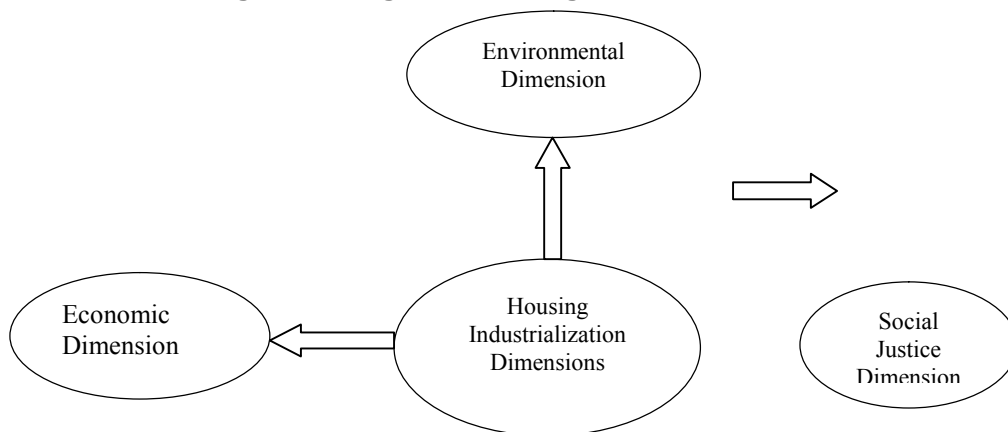


Figure 2- Housing industrialization dimensions

Briefly, the effective factors on industrialization productions are as:

- The continual changes in sciences and technology were the result of the thought and attempts of human being during the history.
- The increase of population raised the need to more production at less time and mass production as sustainable industry is replaced with previous methods.
- By comparing the machine and human, machine efficiency is ten times more than human being and the performance of a simple worker has not economic value at macro and micro scale.
- Mass production and Economy of Scale via observing standards, cheap price, better quality, rapid production and etc. are necessary for the productions of each industrial and semi-industrial country [7].
- Since 1951, the industrial production of building and pre-fabrication was raised in Iran. Various factories entered the country with the evaluation approach and selecting heavy pre-fabricated systems in European countries and spending macro costs. This procedure was not successful due to dependency to the order of great construction projects and most of the factories were closed. Today, based on the residential industrialization issue was considered after stagnation and a new view can be effective in promoting its goals.
- Tehran as the greatest and most populated city in Iran due to some problems such as population growth, accepting migrants, housing shortage and construction old texture need wide construction. Thus, 14695 construction permissions were issued only in 2006 for new construction in Tehran city and showed 35.7% growth compared to the previous year. This growth in 2006 for great cities was 10.2% and for all urban regions in Iran was 17% [7]. The presence of more than 14792 hectare instable area in Tehran, 3268 hectare of which are endangered due to three conditions of instability, impermeability and fine-particles as old tissue, structure condition, performance, urban, social and environment infrastructural services and it needs renovation [7]. The current problems of building construction are non-standard materials, the lack of supervision on materials production, wide employment of illiterate seasonal workers and generally technology poverty and relying on old and inefficient methods. Materials durability, implementation speed, reduction of materials wastage, avoiding energy loss, light weight construction. The resistance of the building to the accidents and using skillful human resources, building industrialization as one of the most important solutions are used and besides observing the standards and regulations of building stability in various climatic conditions and seismology, the speed of implementation of building projects is increased. The present study investigated the design of residential complex in Tehran suburb with the approach of industrialization.

Study hypotheses

First hypothesis: Building industrialization in housing dimension is one of the most suitable solutions in solving the current problems of housing in our country.

Second hypothesis: Housing industrialization at the same time with the residents needs besides improving the life quality can increase the public acceptance and accepting and its progress in professional community.

Study method

The present study was analytical-descriptive and applied. In other words, after scientific description, the data were analyzed and finally scientific and logical result was extracted of this analysis and it was presenting the alternatives to improve the plan based on the goals and selecting the optimal choice. Based on the study data, the study method was qualitative and based on analytical process. This study was done by document and field method and they data were analyzed. In document stage, the data was collected of the books, articles, studies, maps, aerial photos and internet sites. In field studies, besides observation and field interpretation, updating the maps and collecting data were done. The major resources were the books and specialized journals and related study plans and using information world network. In region survey, descriptive-analytical and inference methods were used. Direct observation and image method were used in field studies. The results of the studied region and environment survey in inference-reasoning method were analyzed by SWOT technique. Finally, by extracting the opportunities, limitations and threats, the strategy was selected and policies, solutions and recommendations were presented.

Study findings

PLSC system

Using PLSC system due to great benefits including high quality and speed of construction and replacing the weaknesses of the systems and combining the strengths of this proposed system can be more common. In the selected system, it was attempted to cover the weaknesses of the systems by other pre-fabricated systems to achieve a good combinational system. For example, in pre-fabricated system, beam and concrete column are combined due to the limitations of transportation of columns with metal connections and in columns, there is share tension and not observing the pre-fabrication principle and in LSF system, the number of limited storey is the greatest limitation and in metal structure after

implementation of the structure, not using the other pre-fabricated system for the ceiling and wall are other drawbacks of this system and in combined system of PLSC, all the strengths of the systems are used.

The introduction of PLSC composite system

The implementation system of PLSC is expressed briefly and the components of PLSC system PLSC system

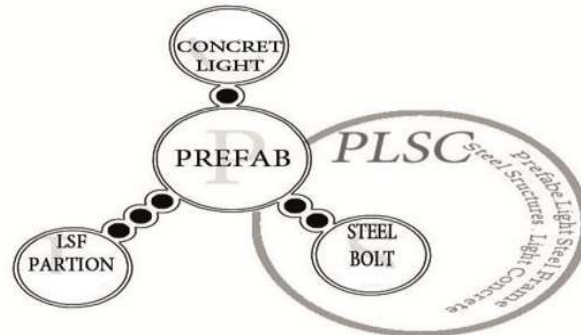


Figure 3- PLSC system

The major goal of using this system is improving construction materials and using pre-fabricated parts in Engineering construction. This attitude in construction forces increased the resistance of buildings structure, short construction period, reduced implementation costs and minimizing the building waste in the workshop.

The components of PLSC¹ system

In this section, besides introduction the components of PLSC system, a brief explanation of the implementation of each section is presented.

- Foundation: To install the pre-fabricated metal columns and system set up
- Concrete pre-fabricated foundation with pre-fabricated frames is implemented in regulated places

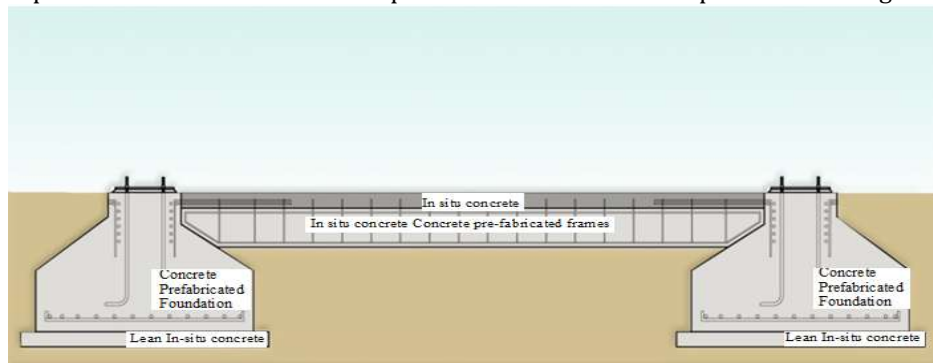


Figure 4- Foundation of PLSC system

Structure

Using steel bolt and nut prefabricated structure increases the construction quality and increasing the implementation speed of steel and by modular system, the wastage of beam is minimized.

¹<http://www.steelfroming.org>

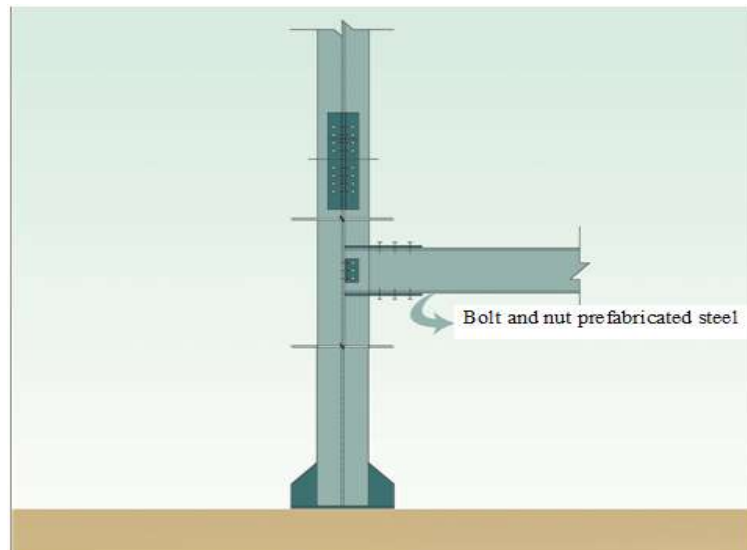


Figure 5- PLSC system frame

Structure

The constituent components of walls are LSF building system, the walls in this system are installed as panel to separate the internal spaces of the building and external façade of the building is installed as modular. Steel studs are pierced before passing electric and mechanical installations and these studs are top to bottom with distances 40-60 cm and rounds (the main horizontal elements) are also connected and by installing gypsum or cement panels are built as panel and an example of LSF wall is shown in Figure 4. The wall interior is covered by gypsum board, MDF sheet, PVC sheet, cement board, wooden boards and for the external cover of the wall, sandwich panel, cement fiber and cement board and tile up method and by Rabits and traditional façade construction (brick, metal stone façade and etc.) are used. The covers added in two sides of walls increase the seismic resistance of the wall to 40%. The common covering in LSF system is shown in Figure 5.

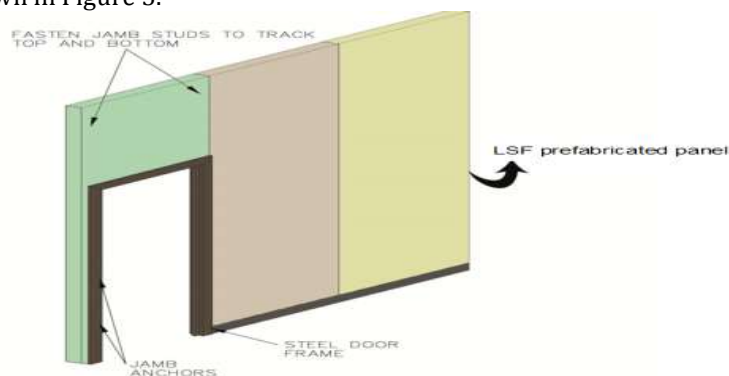


Figure 6- PLSC system walls

Ceiling

Various methods are used for the ceilings and roof in PLSC system as the planar simple forms to the crossed with unequal gradients are used. This method of implementation of roofs and ceilings are including:

Middle ceilings (storey) in concrete slab system with final flooring are installed based on finishing table and for the roof, steep ceilings with the minimum gradient is used. One of the important features in PLSC system is creating good architecture form based on structure frame as good variety of architecture plans in PLSC system to traditional system of construction provided the conformity of the system with the local architecture. Despite the traditional systems that after the final stage, the finishing form of the building is not determined, in PLSC system, there is a short distance between first stage and finishing stage. The finishing stage is done rapidly and easily and the final stage of construction in PLSC system has high precision and quality to other applied systems in construction. A sample of finishing in PLSC system and its final plan are presented in Figure 7.

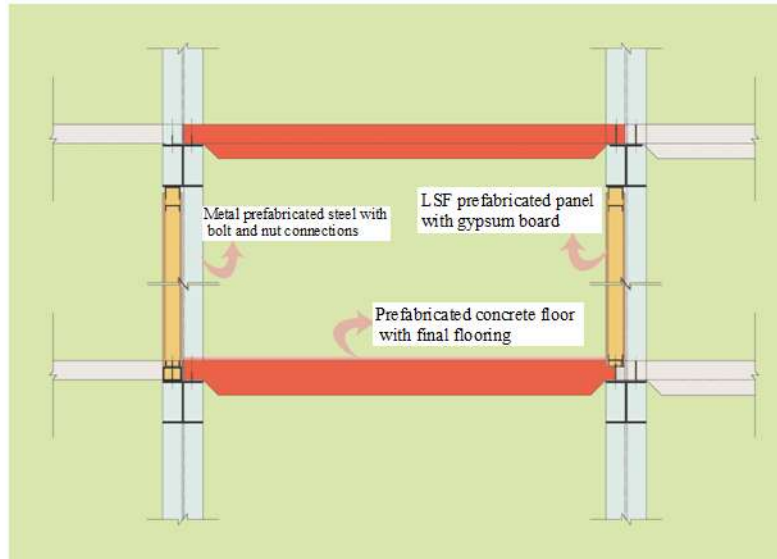


Figure 7- Ceiling of PLSC system

Installations²

In this system, mechanical installations are installed as pre-fabricated cells in WC and bathroom and are connected to building ducts. The electrical installations are considered in each panel and are connected by a socket and plug at the end of wall, the repair or changing some parts are easily done and as one of the benefits of PLSC increases the useful life of the building.

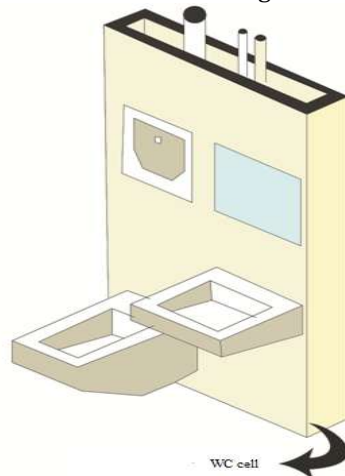


Figure 8- The installations of PLSC system

2.4 The benefits of using PLSC system in building construction industry of Iran

Based on the items presented in the previous sections, PLSC systems in construction industry have great benefits and the most important ones are presented in Table 2-3.

Table 10- The benefits of using PLSC system for various groups (source: Author)

No	Groups	Benefits
1	Designers	Flexibility in design of modules, variety in façade materials based on design modules, meeting the regulations of building standard, designing a modern building system, observing the regulations of discussion 19 automatically
2	Manufactures	The speed of system implementation, reduction of human resources costs, low stopping, parallel activity without stopping in other building sections, resistance maintenance, easy installation of utilities system, needing low space for workshop, safety in workshop, prefabrication and mass production, reduction of costs
3	Users	Low operation cost, good voice performance, healthy internal environment, increasing internal space

²<http://www.steelframingalliance.com>

4	Authorities as supporting environment	Low materials, less traffic and transportation, avoiding energy loss, clean construction workshop, reduction of energy consumption.
5	National resources	Needing a few raw materials to the traditional systems and minimum materials wastage

Table 2- The benefits of using system

No.	Benefits	Results
1	High resistance Precision in details	Suitable seismic performance Elasticity behavior of the structure
2	The lack of delays of weather in production, construction, installation and building the structure	The considerable reduction of construction time Rapid return of initial capital Economical housing construction
3	High resistance to wearing and termite, uniform quality, recovery	Conformity with environment and observing the construction principles and durability of the structure, increasing the durability of building, reduction of maintenance of the building

The results of PLSC system

By the investigations in the previous sections and the comparison between the PLSC system and other systems, the results are including: PLSC system is used in construction industry and it has many benefits and the most important benefits are increasing the construction speed, increasing the durability and life and low energy. The increasing demand to creating required structures with various applications with residence and it is required to use new systems with prefabrication capability. The considerable benefits that were used in the previous sections have high application and they are rapid without creating any stopping in various uses. Building 1.5 million residential units annually and producing thin sheet provided the construction of pre-fabricated factories of PLSC system with rapid structure capability and internal and external components.

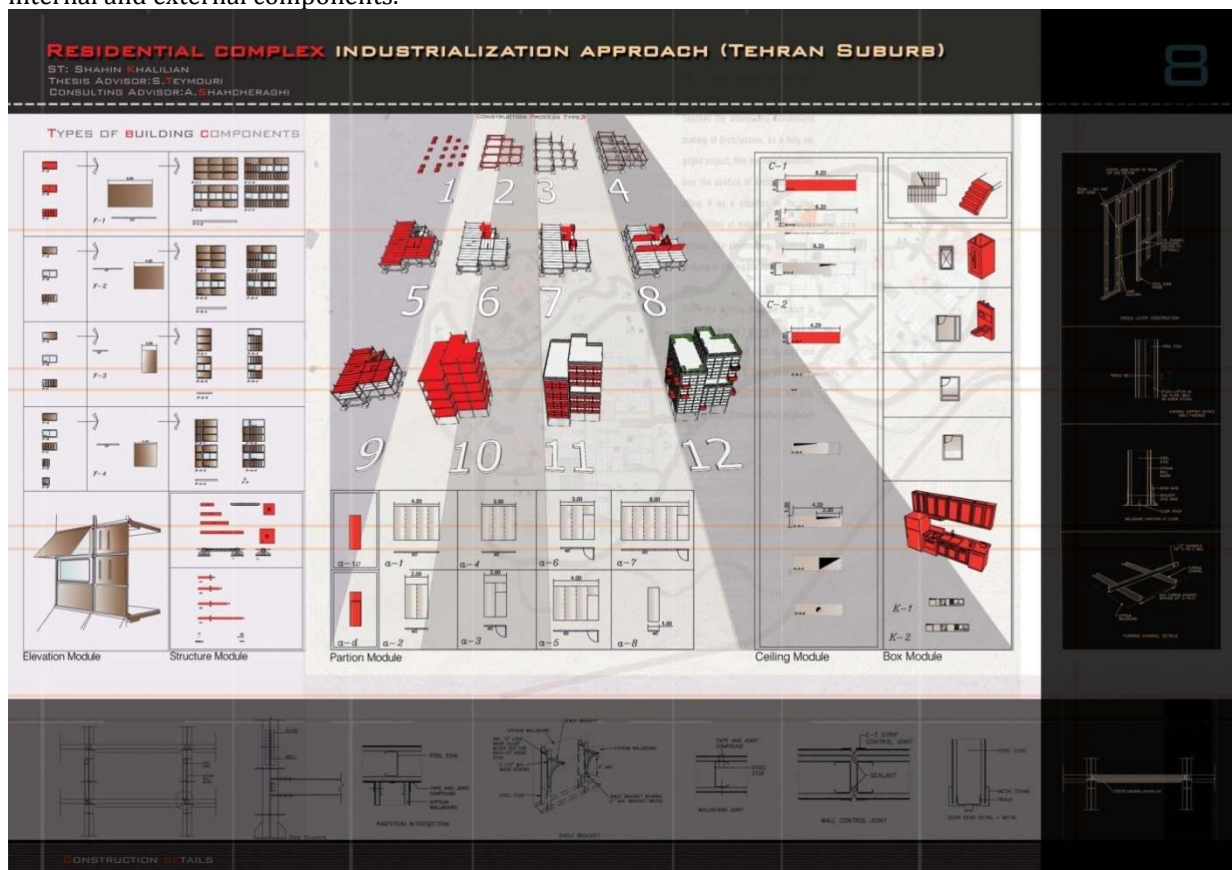


Figure 9- PLSC system

The ideal residential complex

RESULTS AND DISCUSSION

In the physical plan of the required plan, to achieve the ideal residential complex, the followings are considered.

- 1- Improving and consolidation of social relations between the residents of the complex by creating the small and big squares for the residents and creating some spaces for visiting and rest
- 2- Considering the leisure times of the residents namely the youth and adolescents and by providing sport fields and good facilities we can achieve this result.
- 3- Establishing security in sites and blocks and via locating and suitable density of the blocks, as there are no open spaces without any supervision. The blocks height is ranging 4 storey to 6 storey and the units in each storey are 3 to 5 units to consider reduction of population entering the blocks and controlling them.
- 4- Improving the social behavior of the residents in block and by locating the rest of service spaces in proximity of the scale of a block, we can achieve this goal and it is caused that the neighbors get familiar with each other and helping and high security are improved in emergency time.
- 5- Increasing the quality of residential units and optimizing them by using building industrialization
- 6- Involvement of the residents with nature by roof and using them as service space of the residents for gathering and using green space in the blocks in the storey and porches.



Figure 10- The design process in industrialization approach

Design process in industrialization approach of the residential complex

- 1- Designing the blocks of the complex,
- 2- Modular design of the complex,
- 3- Combinational design of building process of planar elements, block,
- 4- Minimizing the number of modules,
- 5- Variety with the limitation of the number of modules,
- 6- Familiarity with the new methods of construction in Iran,
- 7- Determining architecture module,
- 8- Determining structure module,
- 9- Minimizing materials wastage,
- 10- Considering the axes of design.

Some main goals are considered in design process:

- 1- Giving importance to public to private fields in complex design
- 2- Considering the identity elements to the space as porch, yard and flower bed
- 3- Clarity of the complex
- 4- Making the residential units as basis in design of residential complex
- 5- Giving importance of open spaces defined in design of residential blocks
- 6- Climatic permissions determine the direction of buildings
- 7- The influence of surrounding constructions on design
- 8- Giving importance to the pavements and open spaces to rider access

CONCLUSION

Thus, in the design of residential complex with industrialization approach in its design process, many items are important as considering the plan, stability and social approaches. Finally, a proposition is presented for industrial mass production of housing. There are common approaches between structure engineers, architects, factory owners and clients and they are presented in conclusion:

- 1- Type of system
- 2- Series importance
- 3- The issue of types and limiting them
- 4- Exact supervision of similar types
- 5- Scale coordination
- 6- Easy facilitation

It is required we consider construction and production planning as a complex not as separated and planning can lead to success. Thus, the projects constructed by traditional methods are not compatible with the building industrialization requirements, although they are also used again. This issue shows our incomplete thinking to building industrialization. Building industrialization is a completely independent field. We should think more about progress to make it more independent. The current permission system is not satisfactory as it only developed the traditional and common methods and made some problems in progress process. Maybe we wait for a crisis to make progress. The decision makers of building not only accept any progress, they disagree with it. Their reaction to construction methods is encouraging if it is profitable.

Our buildings shouldn't be only described and they should be analyzed basically.

RECOMMENDATION

The date of industrialization buildings is determined by the engineers and contractors but now architect should consider his position and this is possible only by reviewing the planning of architecture training in Iran and the students should learn scale construction to do designing based on training industrialization. There should be close collaboration between architecture schools in Iran and construction industry. The students get familiar with construction and they are trained to eliminate the problems.

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