Improvement of Iranian construction industry

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ABSTRACT: In recent decades attempts have been made to improve productivity in the Iranian Construction Industry by importing foreign technology and by the industrialization of building production. A research undertaken by these authors shows the efforts have largely failed. One of the reasons for the failure is lack of an adequate earthquake resistance of the buildings constructed based on imported technology. The research takes the premise that rather than introducing radically new methods of construction which ignore the existing structure of the construction industry and construction skills, improvements may be achieved by building upon this structure and the skills. What we were looking for, as a secondary goal in the research was a wider improvement of building productivity for the industry.

The Iranian Construction Industry, as in other developing countries, has both formal and informal sectors. The formal sector is the more modern part of the Construction Industry and the informal is the traditional industry (Mimarzia, 1995). There are also the private and public sectors. The public sector is formal and the private sector of the Construction Industry is both formal and informal.

One of the assumptions underpin the research was that, neither traditional methods of construction nor modern imported technology can meet building construction demands successfully. In other words, a blend of the two is necessary. This assumption is supported by the observation that the use of modern building materials applied using traditional method of construction has caused significant problems in earthquake resistance.

This paper considers the nature of Iranian Construction Industry and its environmental conditions. It discusses specific problems and their cause and effects focusing on critical problems to identify the ways to improve building productivity of the industry.

Conference theme: Social and political issues in architecture
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INTRODUCTION

Traditional construction in detail forms and process, which gradually developed through the process of trial and error, is the result of the collaboration of traditional professions, the Iranian traditional architects, mirmars, clients and users over generations. Mirmars have created a strong co-ordination between architecture and the built environment for thousand of years based on the socio-cultural and geographical conditions of the country. This aspect of Iranian traditional building will therefore be discussed.

In the modern sector of the industry in Iran, observations about the inadequacy of modern construction forms, and the failure of industrialized efforts, may be linked to the inadequacy and lack of resistance to earthquakes. It was widely believed that those who were not part of the Construction Industry that the only way to improve the Construction Industry lay in the adoption of industrial methods. Many changes, regardless of their negative or positive effects, were caused by this decision to be beguiled by the attractions of industrialization and ‘rapid development’. This attitude ignores the experiences of the past generations.

In spite of the failure of industrialization in Iran (Mofid, 1987, p. 172), it has commonly been said that the ultimate solution for building shortages is industrialization and prefabrication of building (Sakhteman, 1990). This attitude to radical change is adopted without any comprehensive study of the potential of new and imported technologies to undergo adaptation to the current conditions of the country.

It is not claimed that the transfer of advance technologies from the developed countries is doomed to failure, but the import of advance technology with no serious attention ‘to provide a hospitable environment for its efficient use’ (Mofid, 1987) led to failure in the case of Iran and other developing countries.

1. IRANIAN BUILDING INDUSTRY IN THE CONTEXT OF CHANGE

For the four last decades the Iranian Building Industry has been heavily engaged with production of residential buildings, especially private housing development, with comparatively few infrastructure projects. Lack of infrastructure and skills has been a barrier in the development of industrialization especially for industrial building construction. A new generation of advanced technology was introduced into the country without attention to existing skills and without adequate preparation for its requirements. Such technological changes in the Construction Industry in Iran have widened the gap between the traditional construction methods and modern production systems. As a result traditional methods and skills are mostly being abandoned. Ignorance of existing traditional methods of construction and their related skills constitutes major problems in the modernization of Iran.

Conventional methods of building construction in Iran were developed because of the need to meet a growing demand. The term ‘conventional methods’ here means the methods which mostly are in use in the country. One of the major characteristics of the methods is that of the
use of modern materials allied with a mixture of modern and traditional methods of building construction. The conventional methods are neither vernacular nor modern and they are classified by their roofing or flooring systems. Their development was based on the importation of modern materials and associated production systems. This had some side-effects and caused problems in building forms, but the experiences of the last four decades cannot be ignored and the values of the traditional forms of building should at the same time be preserved. What we propose to do here is consider whether it is possible to improve the standards & productivity of building in Iran by starting with and improving upon aspects of traditional construction rather than abandoning it for something radically new.

To meet the need, the capacity of the Construction Industry needs to be doubled. One major recommendation for increasing construction production is in the use of industrial construction systems. Changes are indeed essential, if the output of the industry is to meet the demands of the country. But it would be a serious mistake to assume that a change from traditional to modern imported technology is necessarily the only way of meeting the demand. Revolutionary technology and radical change, while tending to ignore the experiences of the past, resisting the diffusion of new techniques which takes time to be adapted. There is a reviewed literature on the process of diffusion of innovations by Rogers (1994). In Iran, it has commonly been said, the ultimate solution for building shortages is fully industrialized prefabrication of building (Sakhteman, 1990). An imported advanced system, which is strange and incompatible with the current condition, cannot be adopted immediately in a sudden or rapid development.

Mofid (1987, p173) argues:

Clearly there exist major differences in the physical, cultural, religious, historical and socio-political aspects of Iran and the Iranians, to those of places from where technology was imported, so that the problem of 'inappropriate technology' may well have arisen in the case of Iran.

Ghanbari Parsa (1989) quoting Chabbi (1988) points out that:

The modern building construction methods which depict the glossy image of the technological developments of the current international norms and so valued by the elite, are seen as the only course of achieving rapid development.

This approach to technological development is in conflict with the local conditions in many developing countries, and as Giffilan (1935) and Mofid (1987, p267) have argued, development is an evolutionary rather than revolutionary process. The economic aspects of the building construction and the attractions of modernity, have created a problem for developing societies with their different socio-cultural backgrounds. Many changes, regardless of their negative or positive effects, have come as a result of a harsh decision to follow the attractions of 'rapid development'. Such sudden changes, are inappropriate in many developing countries, including Iran. Alternatively, many of the changes in traditional methods can be attributed to the use of new materials and components, combined with the introduction of new technologies which take into consideration the existing situation and not to a dramatic change which may 'sweep construction' (Hawk, 1992, p. 1). Development as a product, is 'created over a long time with hardworking creativity' (Mofid, 1987) and 'many small perfecting' (Giffilan, 1935) innovations. This process like all processes of changes, as well as technological changes, cannot be achieved suddenly as a 'rapid development'. By contrast, any change on the basis of traditional methods and the use of available skills should and indeed will continue to fulfill an active role for the performance of the industry and will not put a brake on its performance.

A new technology should be based on what is already available. A gradual development policy based on the existing skills can stabilize the process of change. In the case of Britain, for example, Yeomans (1992) believes that the process of change to a new form of roofing that occurred during 18th century, was a gradual change rather than a revolutionary one. Although the change in competing techniques was among a group of craftsmen, in the context of old methods of the roof construction, Yeomans claims that new methods did not immediately replace the old methods. They were gradually adapted and a process of dissemination took place in which new ideas were taken up and used by the carpenters who had been trained in the old ways (Yeomans, 1992, p.198). Because as Yeomans noted, the technological development is a gradual process.
2. TRADITIONAL / INFORMAL SECTOR IN THE CONSTRUCTION INDUSTRY

The Iranian traditional building construction sector has created a rich architecture and appropriately built environment—appropriately in terms of either culture or climate. Construction methods have been used and developed for hundreds of years according to the varied geographical and indigenous conditions of the country. These methods of construction are tried and tested, developed gradually and have performed successfully. Iranian traditional architects (ostad raybar, ostad in Persian) mean a highly skilled and experienced person; this term applies to all fields and master masons (ostad banna) have practiced for many years an appropriate, creative, and innovative technology compatible with the environmental features and the availability of skills and local materials.

Mimars have created artistic buildings which have withstand many disasters, amongst them destructive earthquakes. These architects played the main role in developing various techniques and in creating a harmony between environment, nature and culture.

For many years in some parts of Iran, traditional architects or master masons acting as general contractors were permitted to design a building of any size or complexity and supervise its construction, without applying for either planning permission or building approval. Each of them, however, enjoying a good relationship with his client. At present, this relationship is changing but may still persist in rural areas.

The characteristics of the traditional method can be defined as:

- Readily available materials.
- Available distribution system for building materials and components.
- Existing systems of building methods, which are used, are adapted to available resources and skills and are in harmony with the geographical and socio-cultural condition of the country.

Traditional self-sufficient self-reliance construction methods were based on standard measurement and modular co-ordination. Proportional design of forms and functional aspects of Iranian architecture created various forms of structures, for example, towers, bazaars, wind-catchers, bridges, fortifications, gardens and car-van-sara-s (caravanserais, Car-van-sara, Persian word which in English is caravanserai or caravansary meaning ‘inn with a large central courtyard where caravans can stay for the night’) and even watermills. Unfortunately most of these forms of buildings are no longer used. For example the wind-catcher, or badigr, which was used in warm areas, acted as an air-conditioner to cool the inside of buildings by sucking wind into the building and passing it through a space over water and blowing it into rooms and spaces. This element of building affects both design and layout. Because of complexity of its construction, this self-sufficient air-conditioner is now replaced by electric air-conditioners.

The Iranian building tradition and craft-based construction depended upon the relationship between the client and mimar or banna as general contractor, who was responsible for both design and construction. This method worked well throughout many centuries and was taught by masters to apprentices. The reasons for its success are:

- simplicity of work in terms of lack of diversity of materials and methods.
- clients have no knowledge about the technical aspects of building construction and this was supplied by the builder.
- responsibility for both design and construction was undertaken by a single party.

In traditional construction methods, Iranian houses are faced with some conflicts in the applied method and building elements. For example, in many Iranian houses in rural areas and even in many cities, the use of wooden beams for spanning roofs and floors was popular. Because of heavy material applied, to provide both thermal and water insulation, those roofs have become very heavy. According to the Iranian Code of Seismic Design (ICSD), if it is too heavy and is not monolithic such a roofing is not acceptable. This conflict actually has made a big change to the roofing details and consequently the whole construction method. The most important implication is that if traditional methods of construction are to survive, they must be applied at a higher level of efficiency, and must be able to compete with modern imported methods or any other modern method of construction.

3. MODERN/FORMAL SECTOR IN THE CONSTRUCTION INDUSTRY

The changes to the industry could be identified as three major periods. The first (1908-1951) is started with the discovery of one of the biggest oilfield in Masjid-e-Suleiman in April 1908 and the establishment of Pahlavi dynasty as a result of the fall of the ‘constitutional’ revolution in 1925, and imposing the western’s values. During this period, the 1933 Street Widening Act, and tearing down of Tehran walls in 1937 and large scale demolition of city centers in the country, execution of the first public construction of railway by foreign contractors in 1938, establishment of educational institutions along to the western values such as Tehran School of Fine Art, The construction of American College (Alborz) with the western size brick, It has been three major In 1989, as part of his doctorate programme, Ghanbari Parsa looked at the “Interaction of development policies and the construction industry in Iran” he has identified changes in the Iranian Construction Industry through three periods of time.

The modern Construction Industry was established in 1927 by the first infrastructural railway project linking the Persian Gulf to the Caspian Sea, a distance of 1,394 km. This railway project was important in shaping the character of the Construction Industry. The project took 11 years to complete and cost 150 million dollars (Pesaran, 1994). The railway construction was completed with the help of Euro-American contractors who carried out the main work. Iranian contractors as subcontractors first appeared in 1939. During 1940s, the modern industry was shaped by the idea of ‘economic planning’ which was first suggested in a 1939 memorandum (Mehner, 1978, p.176) which was influenced by the completion of the railway project. The idea was then followed by the requirements of the First Development Plan (1949-1955).

During the First Plan, a separate approach in the areas of design and construction grew sharply with the increase of Iranian contractors. However, because of the low capacity of the contractors and the consequent low capacity of the industry, government expenditure was 30% of the total of 21 billion Irs (Iranian Rial). During the Second Plan (1955-1962) the number of contractors grew and at the end of the plan, the BPO (Budget and
Planning Organization) introduced a system of classifying and qualifying local contractors. As one of the modernization and industrialization targets was education, the establishment of the Fine Art School of Tehran University in 1938 following the ideas of the School of Beaux-Art of Paris, was the first example of the institutionalization of architecture and construction education in Iran (Wilber, 1986?). Andrew Godard, a French archaeologist, was the first appointed head of the Fine-Art School. As he was an archaeologist, he was interested in the products of Iranian architecture, but not in its processes of construction. As a result the traditional Iranian architects, mimars, were ignored and foreign educated architects were appointed to teach architectural subjects. The effects of a European style of architecture accompanied by modern methods of construction, changed the fabric and physical appearance of the built environment in the country with the appearance of high rise buildings. This was the first indication of the rupture between new construction works and traditional Iranian architectural values. Also, as a result of the modernization of the country, the “big push policy”, and the adoption of Western construction technology and the use of modern materials, traditional building construction methods have been changed and the domestic methods of construction production have been greatly influenced by imported modern production systems. Iranian construction development has been affected by both Westernization, and more significantly by the development plans of 1949-1977. The physical development of cities and imported Western technology resulted in a new way of life which was un-adapted to Iranian culture and social conventions. This could be viewed as the turning point in residential construction, moving away from the courtyard Iranian house form and the one or two storied courtyard houses which were built by the mimars who were aware both of architectural values and relevant building technology (Ghezelsiush & Abozia, 1985).

Construction planning process, which used to be planned by the Government from the end of the Second Development Plan (1955-1962), focused on the physical development of cities with the use of modern construction technology and building materials, especially in structural work. Unfortunately when new materials and methods were introduced into Iran, there were neither the adequate skills available to use them nor the adequate training to generate these skills. The result was a poor standard of construction which had an adverse effect on the earthquake resistance of the buildings which were then being erected. This problem was exacerbated by the high densities of these new developments. The result was that the adoption of new construction methods increased the risk of failure during earthquakes. Most speculative builders who constructed houses and apartment blocks for sale, were unaware of earthquake resistant techniques. Speculators were interested in cheap materials and labor and did their best to reduce building costs and sacrificing building quality to gain more profit. The use of inadequate materials in the fabric of the buildings hidden under beautiful and hypocritical finishes, was common.

4. INDUSTRIALIZATION IN THE CONTEXT OF IRAN

Large scale projects are government owned but are usually built by the private sector. Although the private sector is primarily concerned with investment in small scale speculative works and about 95 percent of housing developments (Akhoondi, 1994) which have been encouraged by banks’ financing schemes. The construction technologies employed in the large cities, use the most advanced equipment and machinery, including tower cranes and ready-mixed-concrete trucks, rather than the labour-intensive construction techniques which are employed in the less wealthy small towns. So it was manifested in the form of a rapid increase in the price of building material and labour as well as tax and service charges for any new development which in turn resulted fall in the demand. The shift from traditional materials to new modern materials means a shift to imported building materials and also building material production systems and their associated factories. This caused considerable increases in overheads. Building material cost is a considerable portion of overall building production cost. Tabesh (1989) states that, this could be “... about 2/3rd to 3/4th of the building’s overall costs’. In the case of modern methods of construction in Iran, ‘the foreign currency cost of building materials is 98% of the total currency costs of the whole building’ (Tabesh, 1989). Accordingly, these figures indicate the effect of construction costs which may reduce people’s motivation to build earthquake resistant constructions. Dependency on foreign building materials has grown with the introduction of the modern Construction Industry and the substitution of materials with less dependency on foreign currency, may save overall building costs and also could help the execution of earthquake resistant construction. Dependency of foreign building materials mean the imports of factory and its production system as well as the imports of ultimate building materials. For example, because stone is largely imported while concrete may easily be produced locally, the substitution of reinforced concrete for steel frame would reduce the dependency on imported materials.

In Iran there has been a misunderstanding of industrialized methods of building construction. It is the confusion between ‘factory production’ and ‘industrialized methods’ of building production and the ‘factory production’ is regarded as the only industrialized building construction. This confusion had led to the assumption that the traditional methods are in-capable of being adapted to a factory production system and the result was a radical change in the structure of the Building Industry. The confusion has been that, industrialisation of building construction means ‘factory-made’ production system, while as mention in chapter two, because industrialisation is an organisational process, it is applicable to both traditional and modern methods of building construction, one of which the ‘factory-made’ systems. As a result of the confusion, they have come to be regarded as old fashion and hence to be ignored. Perhaps one of the most important parts of the confusion has been this confused approach to industrialized methods of building construction which has caused neglect of the values and potentials of traditional methods. This attitude has led to the un-favored situation where the Building Industry overlooks the valuable features of the existing building tradition. The confusion between industrialization and factory-made prefabricated system in Iran, which also existed in Britain during 1960s (Bowler, 1966, P.315), took place during the 1970s, with the importation and introduction of large-scale heavy prefabricated concrete panel production plants. These development were based on the industrialization policies and the “big push” scheme, of which the Meri Report (1992, p.36) stated that ‘the ambitious development plans of the former regime resulted in
serious imbalance, inflation, and considerable waste. It also mentions that many Iranian and foreign economists criticized the rapid pace of industrialization and pointed to shortcomings in Iran's infrastructure, her transportation and port systems, and particularly to her lack of skilled manpower. This lack of semi-skilled, skilled personnel, and technicians had a restrictive effect on the efficiency of construction activities especially in the imported industrialized and prefabricated methods of building construction. The demand for skilled construction workers, for example, during the Fifth Plan (1973-1977), was 290,000, while the existing supply was 20,000, that is a shortage of about 270,000 (PBO, 1973), which seriously hampered the adoption of new techniques in the Construction Industry.

It was the precast-concrete construction method which was expected to reduce building costs and construction time to satisfy the building needs of Iran, but which failed because of a lack of an adequate infrastructure facilities such as suitable roads and transportation, and a lack of relevant skills.

With regard to the precast concrete construction, Kamrava (1990) noted that:

The ultimate production of the system is expected to be cost-effective and faster in industrialized countries, but execution reality in Iran shows the opposite and is time consuming and costly.

In pursuit of the goal of a factory-made production system being cheap and fast, this goal has not been realized, even in industrialized countries. In case of industrialized countries such as the USA, Jensen (1982) points out that:

A factory-made house is not a radical improvement over one built conventionally. A factory-made house provides about the same quality and the same amount of space at about the same price as a house built conventionally- but with a lot less choice of how it might look.

Having fewer choices of design style, is one of the problems of a prefabricated system, which is why in industrialized capitalist countries, such as the USA, production of prefabricated houses is not profitable, although Jensen (1982) believes that industrialized housing systems are profitable in the more Socialist countries (Jensen, 1992, p129). Perhaps the limited choices of design of the housing products affect the demand for the method. As a lower demand requires an increase in price, this method is subjected to a higher price than ordinary methods of housing construction. In this respect, Cartlidge (1976, p.42) notes that:

It has been said that the use of prefabrication systems are bound to increase in the future because of the serious manpower shortages threatening the industry, but, as yet apart from a few schemes these seems to be little sign of increased use in these forms of construction in the next decade. Prefabrication will reduce the construction time but appears to be unacceptable, because the associated costs are too high.

Generally, cheapness and quickness of prefabricated systems are not achieved even though this result is contrary to expectations. An investigation of eight different school construction systems in six countries, amongst them the UK, carried out by Oddie (1975 and cited in Russell, 1981), shows that: ‘no generally or direct confirmation of cheapness and quickness can be given’ in spite of the expectation of system building which should be cheaper and quicker than the use of alternative methods. It seems that not only in Iran, but also in some industrialized countries there is evidence which shows that the factory-made production system is expensive and an example of this is the concrete prefabricated flats and their disadvantages in Britain (Bowley, 1966, p.257) or the first series of schools in the Canadian SEF? Programme which seriously overran costs (Russell, 1981, p672). Bowley (1966, p.293) argues that a prefabrication system not only does not necessarily require less site time or decrease construction cost but also it does not follow that it will decrease the total quantity of labor required. She asserts that the dream of a fully industrialized or prefabricated system has not been realized:

...it cannot be assumed that increases in prefabrication will increase productivity of the building process. This conclusion is contrary to popular belief. (Bowley, 1966, p.314)

Regardless of the compatibility of most of fully industrialised in a country such as Iran, there was a common attitude that prefabricated building production is fast and cheap. While there has been this question that why the prefabricated building production in the country was not fast and cheap, the system has been suggested as the solution to the related problems of speeding up and reducing costs of building production by professions. In order to clear the issue, it is necessary to look at the philosophy of mass production in the Building industry and examine its implications here.

Kamrava (1990) did not regard ‘this abnormal problem’ as a ‘mismanagement’ concept in the Construction Industry. Because of importance of management in industrialised methods of building construction, it can be argued that mismanagement is at least one of the reasons for the failure of any industrialised method. Management is one of the most important aspects of building construction particularly when modern or industrialised methods of construction are concerned. It is clear that the application of modern managerial and technological knowledge will affect, in one way or another, all those whose lives are bound up with this Construction Industry. Good management of the Construction Industry in Iran is hampered by: lack of adequate data on many aspects of the industry; Construction Industry for construction organisations involved, shortage of skilled and semi-skilled personnel and technicians, inefficient administrative organisations with weak relationship to each other, lack of legislation governing the relationships and responsibilities, lack of a widespread national/regional building code, and westernisation, the national development plans have not produced what they had set out to achieve. The importing efforts, in Iran, not only did not reduce the housing shortage but also wasted existing resources and made the situation worse. Failure to identify industrialization principles as well as a lack of understanding of the current Building Industry, the construction process and its requirements in the country, resulted in the failure of the effort made. Mofid (1987, p.172, 267) argues that, development should not start with the ability to import, but 'with people and their education, organization, and discipline'. He claims that the lack of correspondence between the imported technology and country’s existing indigenous endowments’ is one of the reasons for the failure of industrialization’ in the country. The out-put of the prefabricated production factories in Iran, for example, shows this failure very well. Being of only 17 prefabricated factories, out of more than hundred factories, in operation with less than half of their nominal capacity (Memrazia, 1995) is an indication of the failure of the industrialized methods of building construction.

A lack of proper understanding of the concept of industrialized building production and a lack of attention to the socio-cultural and geographical condition of Iran has widened the gap between traditional construction
and modern production methods. As a result the factory-
made prefabricated systems in the country could not be
made to work at the same time as traditional methods
were for the most part being abandoned.

Construction techniques, are difficult to understand
outside the context of their environment. When they have
been discussed, the discussion has been in general
terms rather than focusing on the ways in which they
have operated. On this point, the author does not claim
that the transfer of advance technologies from the
developed countries are doomed to failure, but the
importing of advanced technology with no serious
attempt ‘to provide a hospitable environment for its
efficient use’ (Mofid, 1987) is doomed to failure in the
case of Iran and other developed or developing
countries. This failure did not only happen in Iran. In
Britain also there were ‘...some attempts to introduce
new techniques or greater prefabrication and a faster
rate of building all of which failed, owing to a lack of
understanding of those factors which affect productivity
on site’ (Cartledge, 1976: P.42). The author is not
claiming that all the factors in these countries are the
same, but an understanding of the characteristics
of these factors is very important.

Criticizing the industrialized building production systems
which were used in the past does not mean that
upgrading the technology in the country and an
industrialization of building construction is unnecessary.
The criticism is made of the understanding of the terms
‘industrialization’ and ‘system building’ and the rate at
which change should occur. More importantly, change
should not occur at the expense of local talents and skills
such as traditional building construction methods. Any
attempt to create change in this context should be in the
direction of improving and continuing existing
technology.

Development of an appropriate technology is not
something which developed countries can prescribe for
developing countries. It must be done by those who are
familiar with the culture, economy and human relations of
that society and preferably by indigenous people who
can discover what is the appropriate and best use of
resources. Obviously existing research, experience and
lessons which already learnt from the people constitute
guidelines for development in these countries.

Industrialized methods and related techniques which
facilitate the organization of work depend upon
repetition. Industrialization is based on the
standardization of building components which in turn
implies a degree of modular co-ordination. These are
prerequisites for the industrialization of buildings.
Modular co-ordination and dimensional standards are not
new concepts (Falamaki, 1989), they are, indeed,
features of Iranian traditional architecture and building
construction which have been applied for hundreds of
years. These features of the traditional construction
methods, however, may be modified by the use of
industrialized methods. In other words there is a possible compatibility between traditional Iranian construction
methods and industrial methods. There already exist,
conditions favorable for new methods of construction.

5. CHANGES IN THE CONTEXT OF THE IRANIAN BUILDING TRADITION

Iran has a long and continuous civilization of more than
6,000 years (Pope, 1965, p9) and its traditional
architecture is one of the brightest symbols of this
civilization. Indeed, the magnificent and unique
traditional architecture of Persia has a system and style
all its own example of which may be found at Persepolis,
the architectural features of such cities like Yazd and
Isfahan and their Islamic monuments, mosques, ancient
palaces, and towers. At present there are still more than
a dozen masonry buildings that have a history more than
1,000 years, in spite of many earthquakes. There is no
denying that many buildings have been destroyed or that
whole cities or villages have been wiped out, but many
traditional buildings have been hit by earthquakes and
have survived. The survival of these buildings raises
these questions: how did these buildings resist so many
earthquakes? How did the buildings perform during the
earthquakes?

Traditional methods of construction need to be modified
to meet growing needs, but they offer an important
beginning. The goal of most research on traditional
Iranian buildings has been the classification, listing,
description of building types, and their spatial features.
Little attempt has been made to link these special
features to the way in which they are constructed.
This author believes that the reason why traditional
construction methods have not continued is that there is
insufficient knowledge of their construction operation. It is
not enough to say, for instance, that traditional buildings
are built of adobe and mud. The traditional construction
methods contain some remarkable techniques in the use
of bricks and mud which enable magnificent architectural
masterpieces to stand up for hundreds of years but there
is at the present time an insufficient understanding of the
way in which adobe walls or those of similar construction,
respond to earthquake loads and. The question
addressed here could be the way in which the adobe and
sun-dried bricks construction have resisted so many
destructive earthquakes. Research on earthquake effects
on Iranian traditional architecture is almost non-existent.
The reason is twofold: modern engineers know very little
of characteristic of traditional buildings and the architects
who research traditional buildings are unfamiliar with
earthquakes and structural dynamics. This, however, lies
outside the scope of this thesis which is concerned more
broadly with methods of construction.

Drawing lessons from traditional construction techniques,
and improving upon them could help their continuity
which may in turn support modern ‘conventional’
methods of building construction in the country. In the
context of the use of new materials and the change in
current methods, Wuff (1966) pointed out that:

In the process of industrialization, one fact is undeniable,
namely that the country’s age-old tradition in industrial
arts, always adaptable to new conditions, has been and
will be of great help in this most significant change.
The resistance to earthquakes of traditional buildings and
learning lessons from it, is of major concern. This lies in
the role of the traditional profession and its architects
(mimars), in the associated design and construction
process and in the geometrical configuration of these
traditional buildings.

Iranian traditional construction methods, gradually
developed through a process of trial and error and are
the result of a collaboration of traditional professions: the
mimars, clients and users over the generations. Mimars
created a co-ordination between architecture and the
environment for thousand of years based upon the socio-
cultural and geographical conditions of the country.

6. IMPROVEMENT OF BUILDING PRODUCTIVITY AND EARTHQUAKE PROBLEM

It was shown that to improve building productivity a factor
that should be taken into account is the resistance of the
building to earthquakes. As this problem is, to a large extent, the result of poor workmanship, a key factor is an improvement of standards of workmanship. This depends upon the use of knowledge at the design stage and training for proper execution at building site. This is not an issue of workmanship alone. It has been shown by reference to the problem of the introduction of reinforcing methods into brick work that it is essential for issues of workmanship to be considered at the design stage. It is not merely a problem of providing adequate training in manual skills. There is the equal task of providing training for designers so that they will take account of the processes of construction. Similarly the management of the construction process may be seen in a similar light, although this aspect has not been examined in any detail.

Earthquake can play a key role in the improvement of building productivity. What basis do we have for assuming that there is any incentive on the part of the government to carry out the necessary research or to implement any recommendations of the kind being made in this paper. Will fear of earthquake damage push the authorities into taking action or will this simply be seen as a problem for the building industry alone which it will have to solve by itself? In fact after the North Earthquake in 1990 the government noted that the cost of the damage incurred was comparable with that of the damage caused by the eight years war with Iraq. The government is therefore well aware of the economic cost of earthquake damage. Therefore, even though there may be no political pressure on the government to act to improve the safety of buildings, it's own concerns for the economic damage which earthquake may produce is likely to encourage them to take appropriate action. There is also an economic effect on the government itself because of the political pressure which occurred after the earthquake for the government to rehouse those whose dwelling had collapsed.

Any development should at the same time help to reduce construction costs. The use of simple or appropriate plant and equipment may help improve the performance of the skilled trades and can play an important role in both increasing building productivity and resistance to earthquakes. The two aspects should be considered together. The problem in the past is that the former has been considered and the latter neglecting. While complex new technologies have been used improve productivity in the developed countries, the use of the same technologies in non-developed countries with socio-cultural differences is likely to be in conflict with socio-cultural conditions and to be inappropriate.

The dramatic changes in the Iranian building construction not only ignored the potential of past experiences and resulted in deteriorating building standard, for example, the development of ‘conventional’ construction methods but also had an adverse effect on buildings in response to earthquakes. ‘Conventional methods, developed on the basis of the use of the modern materials with the application of traditional skills. Unfortunately this change has occurred without any detailed consideration of the earthquake risks involved. The use of modern construction methods was not carried through to proper design and construction detailing and the provision of appropriate skills in training and building controls.

One of the problem areas in the Iranian Construction Industry is a shortage of skilled labor. While the provision of skilled labor by education and training schemes is vital for the industry, training traditional mirmas to improve their knowledge and familiarize them with new technologies may have a significant effect on improving building production. An apprenticeship system of training, which has been a successful traditional system could play an important role in the informal sector of the industry and apprentices may produce better result if they are trained by qualified masters.

This study suggests it is crucial, firstly, to set up a training scheme to qualify and register those who are involved with the Construction Industry, particularly those who are in informal sector. The various organizations which are appointed for the education and training of the labor forces, could then undertake some responsibility for particular training such as the training of unskilled workers or the training of engineers or architects for particular purposes. To improve both building productivity and earthquake resistance, training of architects for understanding earthquakes’ effects on buildings is of prime requirement.

RECOMMENDATIONS

In this paper some recommendations for improving the physical and organizational conditions of both building productivity and earthquake resistance have been implied. They are:

- Building codes and regulations, as well as inspection manuals, are needed to improve building productivity and the earthquake resistance of buildings.
- Registration of all informal trades and tradesmen within the Construction Industry is a significant need if building productivity, particularly of housing production is to improve.
- Improving traditional skills and providing skilled labor and any recommendations for training can effectively improve building production.
- Improving the quality of building materials and the expansion of production of a variety of building materials could provide innovative building techniques to improve both building construction and earthquake resistance. The training of manufacturers has a great effect on this improvement.
- Collaboration between engineers and architects to improve building productivity and earthquake resistance is necessary to cope with the earthquake problems of the country.

REFERENCES


Falamaki, M. M., (1989), Mimari-e Iran as honar ta sanat, The Iranian architecture from art to industrial technology, Magaleh Sakhteman, (Building magazine, in Persian).


Ghezelbash, M. R. and Aboozia, F.(1985), Arefbay-e kalbod-ekhaneh-e sonnay-e Yazd, Courthouse houses of Yazd. A research carried out for the study of three different parts of the early Ghajar period (1786-1925) in city of Yazd. The research was commissioned and published by the BPO (Budget and Plan Organisation), 1364 (1985).


Wulff, Hans E., (1966), The traditional crafts of Persia, their development, technology, and influence of Eastern and Western Civilisations. The MIT Press, 1966