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Affordable Housing and Ways to Achieve Lower Cost and Less Period of Time

الاسكان الاقتصادي وطرق الحصول على اوطأ كلفه واقل مدة زمنيه

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Abstract

A housing problem of the problems facing the countries, especially the developing countries. It is essential to provide housing units at the level commensurate with the rapid population growth. Many countries have applied structural policies to confront this problem by relying on the available material and human resources to provide as many housing units to occupy by those who do not have good housing for shelter.

This research targeted the field of affordable housing units in general and the impact of use Structural innovative system in particular, and the impact of the implementation of the new system on the cost and Duration of time needed to accomplish. In order to reach the aim of the research was take advantage of previous research and studies in the field of implementation of housing units by insulated concrete forms technique shorten to (ICF) technique and adopt this technique for the implementation of residential complexes.

The research reached to propose a new technique for the construction of housing units by the construction of a typical residential house at the headquarters of the General Authority for Housing using the proposed technique. An economic comparison was conducted between the proposed system for construction and traditional commonly used building systems of massive wall system and frame wall system. It has been found that the proposed system is better than commonly used alternatives to an economic life of 33 years,

الخلاصة

تعد مشكلة الاسكان من المشاكل التي تواجه البلدان وخاصة النامية منها، فلابد من توفير الوحدات السكنية بالمستوى الذي يتناسب مع النمو السكاني المطرد. اتبعت دول عدة بعض السياسات الانشائية لمواجهة هذه المشكلة بالاعتماد على الموارد المادية والبشرية المتاحة لها لتوفير اكبر عدد ممكن من الوحدات السكنية لاشغالها من قبل الذين لا يملكون السكن الصالح لايوائهم.

استهدف البحث مجال الاسكان الاقتصادي بشكل عام و تاثير استخدام نظام انشائي حديث بشكل خاص، وكذلك اثر تطبيق النظام الجديد على الكلفة اللازمة للانجاز . من اجل الوصول الى هدف البحث فقد تم الاستفادة من البحوث والدراسات السابقة في مجال تنفيذ وحدة سكنية بتقنية القوالب الخرسانية المعزولة التي تختصر الى تقنية ال (ICF) ، واعتمادها لتنفيذ المجمعات السكنية.

هذا البحث توصل الى اقتراح تقنية جديدة لانشاء الوحدات السكنية وذلك باقامة وحدة سكنية نموذجية في مقر الهيئة العامة للاسكان باستخدام هذه التقنية المقترحة. اكتمل البيت النموذجي بتكلفة قدرها حوالي 449513 دينار عراقي للمتر المربع الواحد، طول الفترة الزمنية التي استغرقها تنفيذ كامل الهيكل 23 يوم بضمنها ايام تدريب العمال ولمساحة اجمالية بلغت 226م^2 وطول الفترة الزمنية التي تنفيذ الانهاءات 62 يوم عمل.

كما اجريت المقارنات الاقتصادية بين النظام المقترح للبناء وبين النظمة البناء التقليدية من نظامي البناء الجداري والهيكلي الشائعة الاستخدام بطريقة الكلفة السنوية بعد حساب كلف الصيانة والطاقة السنوية حيث كانت الكلفة السنوية للنظام المقترح 26945 دينار عراقي للمتر المربع و(36278و34768) دينار عراقي للمتر المربع للبناء الهيكلي والبناء الجداري على التوالي

1- Introduction

As the world's population continues to grow from the current level of over six billion, homelessness and poor housing are increasingly important issues. Approximately 100 million are homeless. When including those whose shelter is termed "inadequate"—lacking access to piped water, roads, electricity, or long-term security—the number soars to over one billion (Habitat World 2001). The major challenge facing the world is the provision of housing that is adequate, sustainable, and affordable.

Adequate shelter is best defined in the United Nation's Habitat (UNHABITAT)

Agenda. According to UN-HABITAT (1996), "adequate shelter means more than a roof over one's head. It also means adequate privacy; adequate space; physical accessibility; adequate security; security of infrastructure, such as water-supply, sanitation and waste management facilities; suitable environmental quality and health-related factors; and adequate and accessible location with regard to work and basic facilities: all of which should be available at an affordable cost." Therefore, from here on, adequate shelter refers to housing that meets these condition.

In 2003 UN-HABITAT reported, an estimated 928 million people living in slums; further, this figure was projected to grow at an accelerated rate if immediate widespread action was not pursued. As a majority of the world's homeless and poorly sheltered dwell in developing countries that lack the resources and technology required to take widespread action, housing conditions are continually deteriorating (United Nations 2003). Due in large part to rapid urbanization and the influx of migrants to major cities, housing and infrastructure breakdown as the competition for limited resources places undue strain on these systems (United Nations 1999). In order to cope, informal housing units are erected, forming the slums and tenement settlements that often landscape these major cities. Overcrowding in major cities has had a significant effect on housing conditions around the world; but homelessness and informal housing are also a consequence of poverty, expensive building materials, poor financial policies—namely, mortgage options—poor planning and development processes, and a host of other factors. While attempts have been made to address many of these issues—through poverty reduction programs, financing reforms, and public housing—the public sector has not been able to make significant progress in the reduction of inadequate shelter. If goals of reducing homelessness and informal housing are to be met, a new framework for housing development must be explore.

One of the greatest setbacks to housing development is the cost of building materials. Approximately 70 percent of a home's cost is derived from the materials used to build it; yet 80 percent of the world attempts to build with materials that are affordable only to the richest 20 percent(Soboyejo 2004). The use of expensive conventional building materials has significantly increased the cost of housing, making even public housing too costly for targeted beneficiaries. Thus, the development of more affordable housing requires the use of low-cost building and construction technique.

2- Housing need after 1997 in Iraq

For the purposes of long-term planning must assess the need for future residential according to the following), (Central Statistical Organization,1997.)

1-Amount of total housing deficit for the base year

2-The number of families that will be added annually on the basis of the annual rate of increase up to the target year

3-Add percentage to total residential projected need for the target year as expected depreciation of the existing housing stock now and this percentage up to 3% of the total residential projected need.

In order to know the number of families that will be added annually to be to predict the size of the population adopting the same annual growth rate for the period (1987-1997) is3.04% and using the compound growth method, predicted the size of the population until 2020 as follows(Al-Saadi,1985.):

$$P_t=P_0(1+r)^n \quad (1)$$

Where r: Compound growth rate
n: The number of years
P_t :Population size for the target year
P_0 :Population size for the base year\1997(22040thousand)

As shown in Table(1)

Table(1)Projected population for the whole of Iraq, (Al-Hamidi,2000.)

Year	2000	2005	2010	2015	2020
Population (thousand)	24111	28005	32530	37785	43888

To predict the size of the urban population have been using the same annual growth rate of the urban sector for the period(1987-1997), a 2.71% as shown in table(2)

Table(2)Projected population Urban and Rural Areas, (Al-Hamidi,2000.)

year	2000	2005	2010	2015	2020
Urban population (thousand)	16242	18565	21221	24256	27726
Rural population(thousand)	7869	9440	11309	13529	16162

To estimate the need for housing resulting from the increase in the number of families that occupy the largest proportion in estimating the need for housing must estimate the size of the family and that this rate held constant is not true it is closely linked by the shortage of housing stock for the number of families, The higher rates of residential construction compared to an increase of the number of families, the lower housing deficit and this decline leads to reduce the size of the family and thus increase the number of new families, thereby increasing the need for residential (Al-Saadi , 1985.)

To reduce the occupancy rates of capita per dwelling was assumed decline in the average size of the Iraqi family for the years that followed in 1997on the basis of increased rates of construction, (Al-Hamidi,2000.) as shown in the table(3).

Table(3)The expected size of the family (individual /family) , (Al-Hamidi,2000.)

Year	2000	2005	2010	2015	2020
Urban sector	7.1	6.9	6.7	6.5	6.3
Rural sector	8.9	8.7	8.5	8.3	8.1
Total	7.6	7.4	7.2	7	6.8

So we can deduce that the number of families expected for the following years by dividing the size of the population on average family size is expected, as in the table(4).

Table(4)Expected numbers of families (Thousands), (Al-Hamidi,2000.)

Year	1997	2000	2005	2010	2015	2020
Urban sector	2060	2287	2691	3167	3732	4401
Rural sector	803	884	1085	1330	1630	1995
Total	2863	3171	3776	4497	5362	6396

Thus the projected increase in the number of families for the period from(1997-2020) is (3533000) added to the housing deficit total for 1997 reached (706,797) housing units with the addition of3%to the total need residential anticipated as a depreciation expected to stock housing in1997, Thus, the total projected need for country until 2020(4,366,990) units share the urban sector (2,974,879) units(1,392,111) units for the rural sector (Al-Hamidi,2000.)

3- The cost of building the housing unit

The cost of building the housing unit influential factor and essential in addressing the need housing association purchasing power segments of many of society especially the layer of junior staff and those with limited income this hand on the other hand linked to the size necessary funding and develop plans and investment projects by the state for projects and complexes housing to reduce the gap prevailing between the need for residential real and actual demand and between demand and supply of residential units.

The construction costs increased significantly from what it was before 2003, which reflected negatively on the increase housing deficit in Iraq, for example, if we compare the cost of building per square meter in 2002 and 2004 to show us that the cost of building per square meter in 2002 was about (46900) dinars(Central Statistical Organization and Information Technology,2002,2003), while the cost of construction per square meter in 2004. (95700) dinars(Central Statistical Organization and Information Technology,2004,2005), but the cost of construction per square meter in 2012. (55000) dinars(Researcher)

The increase in the cost of construction was the result of an increase in prices of construction materials and an increase in the wage labor, table(5) shows the comparison between the prices of the most important construction materials essential used in the construction of housing units and an increase in the rates of the prices they got in 2005 and 2012 for prices the same materials during2002.

Table (5)the prices of basic construction materials for 2002 , 2005 and 2012(Central Statistical Organization and Information Technology,2002,2005,2012)

Material Name	Average Price2002	Average Price2005	Average Price2012
Bricks/number per thousand	24922	112500	223000
Cement /ton	26757	186667	190000
Sand /m^3	3181	17500	27000
Gravel /m^3	3274	15000	27000
reinforcing iron/ton	191969	950000	876000
The cost of building per square meter(ID)	46900	95700	550000

Through this table, we note that the rate of increase in the cost of construction per square meter amounted to about (104%) in2004 than it was in 2002.(Central Statistical Organization and Information Technology,2002,2004),(Baghdad Chamber,2005), and about (1072%) in2012 than it was in 2002, and about (474%) than it was in 2004 (Researcher).

4- Affordable Housing Definition and Characteristic

Affordable housing is one part of the housing market in western developed countries as well as in eastern developing countries. The so called housing is the house that built for residential use which provides basically private and secure place for people to live in. There are many different ways to classified housing, for example, according the provided party standard, these are commercial housing and public housing; according to the business standard, there are general commercial housing and low-profit housing; according to the customers standard, there are social housing and business housing. Housing is not only has the characteristics of commercial profit but

also social security protection. Affordable housing is an important part of social housing security protection, provided by local government to the customers who is low-income household or has lower competition power in social market. Many countries' government use affordable housing policy to organize the social security system.(Jingchun,2011)

When housing adequacy is expressed using the term "affordable housing", it implies that affordability is not a characteristic of housing per se, rather it is a "relationship between housing and people" (Stone,2006a).

Affordable housing is a three-dimensional notion, a triangulation that asks: affordable to whom, on what standard of affordability, and for how long? Further, argues Stone, while housing affordability is an indicator, affordable housing carries the connotation of a standard. An indicator is an empirical metric, usually of the relationship between housing costs and incomes. A standard, on the other hand, is a normative specification of the appropriate value that an indicator should or should not take (Hawtrey,2009).

The characteristics of affordable housing can be summarized as follow:

1. Government involving. As the main provider of affordable housing is not commercial real estate developers but the governments, affordable housing project is planned by the government including the location, housing type, building standards and the level of house price.
2. Consumers are fixed. There has limitation for the affordable housing consumers, like low-income crowd. Government has the principles for affordable housing purchase, like family members, income level and background. It should be noted that affordable housing market is opened to specific consumers.
3. Complicated applicant selection. In general speaking, the number of affordable housing supply is less than the demand, because if the supply is higher than demand, it will fall down the housing price and affect the commercial housing market.

(Jingchun,2011).

5- Commercial Housing and Affordable Housing

Affordable housing is regarded as a commodity and can be transferred in the housing market as the commercial housing. However, affordable housing can only be transferred in the specified housing market and the buyer should be low-income household group. The different between affordable housing and commercial housing are as following(Jingchun,2011)

Table(6) Difference in commercial housing and affordable housing

Parameter	Commercial Housing	Affordable Housing
Developer	Real Estate Developer	Government
Project Fund	Private Fund	Housing Provident Fund
Construction style	High taste living level	Basic living level
Sell type	Public sale	Qualification Sale

In general situation, commercial housing is organized by the commercial investors or real estate developers, the operation and benefit gain become to them. But affordable housing is organized by local government or state government, they design the whole program.(Jingchun,2011)

6- Affordable Housing and Low-cost Housing

Affordable and low-cost housing are often interchangeably used, but are quite different from each other. Low-cost housing is generally meant for EWS category and comprises bare minimum housing facilities, while affordable housing is mostly meant for LIG and MIG and includes basic amenities like schools, hospitals and other community facilities and services. .(Jingchun,2011)

Table(7) The difference between the affordable housing and the low-cost housing

Parameter	low-cost housing	affordable housing
Amenities	Bare minimum to none	Basic
Target Income Class	EWS & LIG	LIG & MIG
Location	Generally within city but can also be located on city peripheries due to high cost of land	Within city
Project Developer	Mostly Government agencies	Private Developers and Government
Mostly available source of finance	Micro finance institutions	Traditional banking system
EMI to Monthly Income	Not exceeding 30 percent of gross monthly income	Not exceeding 40 percent of gross monthly income

7- Affordable Housing Types

Dwelling units differ in sizes and configuration depending on family size and the purpose of their design. This section highlights a range of dwelling units identified within the Global affordable housing sector. There are wide ranges of housing types that may be adopted for use for affordable housing development depending on their suitability. The housing types identified within this range are (Nelson,2011):

1- **Terraced houses** : Some significant features of a terrace house model are flexibility, adaptability and affordability. They can be converted into flats and back again. They can be used to accommodate sharers or families. Rooms can also change function or be linked together. One can reverse the living space, and extend upwards and downwards and even sideways or backwards.

2- **Semi Detached houses** : This is defined as one of the two houses divided by a party wall

3- **Townhouses** : Townhouses are typically two to three stories in height. Some townhouses include separate rental units, either on the top or bottom floor of a three-story townhouse unit, or in a cottage above a detached garage. They generate a sense of individuality without conflicting with the integrating order of a city street or square.

4- **Detached houses** : Detached house represents a desire for individuality and isolation. It embraces both the historic country house as well as the twentieth century housing estate.

5- **Courtyard houses** : Courtyard house demonstrates how indoor space and garden space can be combined in design .In a courtyard house a high degree of privacy is maintained with the living space looking onto an enclosed landscaped courtyard offering a protected garden.

6- **Mansion blocks** : Mansion blocks are often set around a communal square or garden for use by residents and can accommodate apartments and marionettes. The classic mansion block typically accommodated shops on the ground floor, offices on the first, affluent apartments on middle floors and 'affordable' housing in the attic. The contemporary mansion block has evolved, so that it more typically accommodates expensive pent houses at its top.

7- **Decked access blocks** : In 1848 the society for improving the condition of the laboring classes proposed plans for neat, well built dwellings. One model featured flats entered off walkways either side of a shared staircase, and this became known as deck access.

8- Advantage and Disadvantage of Affordable Housing

The arguments between advantage and disadvantage of affordable housing have been in existence for decades. Some researchers believe that the affordable housing is helpful to protect the living right of low-income households. Affordable housing is provided by government, many low-income households can have their own house. But another view believe that affordable housing is management by government, including the price decision which will impact the commercial housing, destroy the freedom on housing transfer market. (Jingchun,2011)

advantages:

affordable housing provides various economic, social and environmental advantages.(Leinberger 2008):

1-**Reduced homelessness and associated problems**. This type of housing is suitable for people who are currently, or at risk of becoming, homeless. Stable housing, in turn, improves physical and mental health, increases economic opportunity (it helps residents obtain education and employment)

2- **Increased household savings and affordability**. Affordable development tends to reduce housing and transport costs, providing savings, particularly for low-income households

3- Congestion reduction. Residents of more accessible, multi-modal locations tend to drive less, and so cause less traffic congestion.

4-**Increased personal security**. Increasing pedestrian traffic and public surveillance tends to increase personal security in urban neighborhoods.

5- **Smart growth benefits**. More compact, accessible urban development tends to reduce public service unit costs, and preserve open space (Litman 2005a).

6- **Increased economic opportunity**. Improved access to education and employment tends to increase employment rates and wages, particularly for people with disabilities.

6- **Economic development benefits**. In many communities, high housing and transport costs limit the pool of lower-wage employees, and therefore local business development, and discourage students, pensioners and artists from living in a particular area, thereby reducing the economic and social activities they support. More compact, accessible, development also increases economic development by supporting agglomeration efficiencies.

However, affordable housing can also impose some disadvantages(Nelson 2006):

1-Smaller lawns and gardens, and less access to open space.

2-Reduced privacy and quiet. Residents of multi-family housing and compact neighborhoods tend to have less visual privacy and are exposed to more noise than in suburban locations.

3-Lost views and sunlight. Tall buildings often block views and solar access

4-Increases in some local public service costs. Lower-income households may increase demand for certain public services, including schooling, welfare, and public transportation

5-Increased transit crowding. Increases in peak-period transit ridership without increased service can lead to crowding.

9- Modern ways of Building

Human societies have become need to modern and contemporary ways of building provides both durability and flexibility in Construction**,** and the preservation of the environment in addition to the speed factor in implementation as joint agents to highlight the economic side of any construction**.** The Public Authority for Housing in Iraq implemented several models for economic houses**,** these models feature fast implementation and low cost of construction in addition to the thermal insulation using modern techniques such as:

9-1 Glass Fiber Reinforced Concrete(GRC)

Concrete reinforced with glass fiber without the use of reinforcing iron at all, allows the construction of residential units multiple floors according to the massive walls system

Consists of:

Portland Cement+ Pure sand+ Glass fibers+ Additives+ potable water+ EPS

(GRC) material like dough they take the shape of the mold in which it will pour, which make the product unable to meet the architects designs.

(GRC) technique have many inherent advantages such as:

-Full of sound insulation and heat

- Reduces the energy used for heating and cooling

- Non-flammable

-Speed of execution

-Not sensitive to moisture and salts

-Weight per square meter including walls, ceilings and finishes does not exceed 120 kg or 10% of traditional construction.

Table (8) A typical(GRC) house information

the year	2012
The Location	Baghdad
Implementing Agency	General Authority for Housing
Implementation period	60 working days
The final cost of the project	110920000 ID
Construction System	massive system
Type of Contract	Turnkey
The number of residential buildings	One typical house
The cost of the typical house	110920000 ID
Total construction area of the typical house	$235m^2$
The cost of the typical house/ m^2	472000 ID
Number of floors	2

9-2 Fiber Reinforced Plastic (FRP)

A plastic (polymer) matrix reinforced with a glass fiber material, Fiber Reinforced Plastic (FRP) composites with fibers bonded together with the help of organic polymers (resin system) are being referred to as the materials of 21st century because of many inherent advantages such as:

- superior thermo-mechanical properties such as high strength and stiffness, and light weight,

- excellent corrosion resistance

- design flexibility

- shop fabrication of FRP results in excellent quality control with lower transportation cost.

- Reduces the energy used for heating and cooling compared to the traditional buildings , allows the construction of residential units multiple Floors according to the massive walls system. **Consists of:**

fibers+ fabrics+ resins+ sizing+ additives+ EPS + coatings

Manufactured in the factory form of a game of (*micano*)in different sizes and shapes, to be transported and installed within the site.

Table (9)A typical house (FRP) information

the year	2012
The Location	Baghdad
Implementing Agency	General Authority for Housing
Implementation period	30 working days
The final cost of the project	172530000 ID
Construction System	massive system
Type of Contract	Turnkey
The number of residential buildings	One typical house
The cost of the typical house	172530000 ID
Total construction area of the typical house	270m^2
The cost of the typical house/ m^2	639000 ID
Number of floors	2

9-3 Insulating Concrete Forms (ICF)

To contribute to the many efforts being made to meet the growing need for affordable housing units, Alternative proposal systems requires to elements of the residential unit ensure the reduction in the cost of the residential unit compared to conventional construction, In this sense the (ICF) technique was chosen so characterized as a system with the following :

-The use of local manpower after of training

-Reduce manpower to the lowest level compared with traditional techniques

-Use of local materials in the process of implementing concrete frame, internal and external finishing can also the use of any imported finishing material

-Reduces the number of heavy mechanical vehicles to the lowest level, which is reflected on the ease of work and reduce the cost

-The high level of thermal and acoustic insulation, which reduces the cost of long-term construction

-Achieve the minimum quantities of construction materials used and reduce the wasted and the damage of which

- Is one of the environmentally friendly technologies for the lack of debris resulting from the implementation of using this technique

9-3-1 System Element

(ICF)) technique consists of two elements, wall elements and a slab elements which are made of the following recyclables materials:

- Polystyrene Panels
- Steel Reinforcement
- Structural concrete
- the finishing material

9-3-1-1 Wall Element

The wall element is basically a reinforced concrete wall insulated by the polystyrene panels, the polystyrene panel works at the beginning as shuttering form and finally acts as thermal, sound and moisture insulations

- Polystyrene Panels

Polystyrene Panels are produced through contumely designed molds. The raw material is called expanded polystyrene (EPS) which is extensively used in industrial, commercial and residential construction.

- Steel Reinforcement

• Vertical and horizontal reinforcement provided according to the loads exerted on the walls based on British Standard Code (BS: 8110).

• Providing vertical rebar extended from the foundation and overlapping with the wall's vertical reinforcement, resists lateral earthquake loads making this system anti-seismic.

- Structural Concrete

Objective desired of concrete blended is access to the production of concrete strongly 25 Newton\mm^2 with density of 1800 kg/m^3

-The Finishing Material

The (ICF)) technique Characterized it accept different types of internal and external finishes like plaster, cement and ceramics, As well as finishing of modern methods such as gypsum boards for walls and ceilings, as well as false ceilings and stone packaging, etc.

9-3-1-2 Slab Element

Innovative design made from steel T beam reinforcement, formwork slabs and reinforced screed. Figure (1)

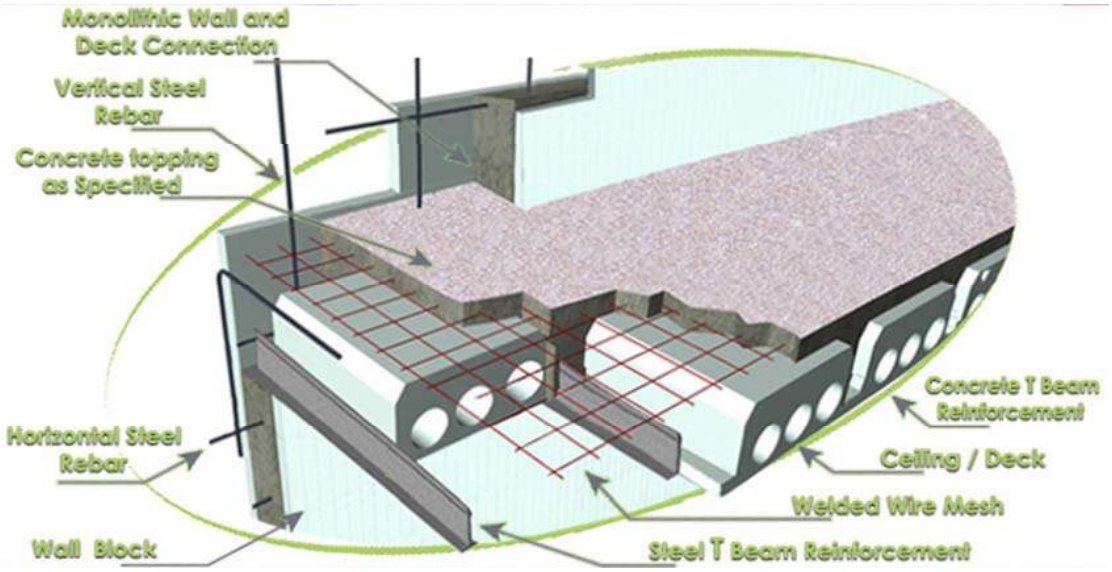

Figure (1) slab element

Table (10)A typical house (ICF) information

the year	2012
The Location	Baghdad
Implementing Agency	General Authority for Housing
Implementation period	85 working days
The final cost of the project	101589900 ID
Construction System	core system
Type of Contract	Turnkey
The number of residential buildings	One typical house
The cost of the typical house	101589900 ID
Total construction area of the typical house	226m^2
The cost of the typical house/ m^2	449513 ID
Number of floors	2

10- Choose the proposed model

The instructions studies the technical and economic feasibility of annual depreciation by hard installment for buildings identified in general by 4%annually,as identified in the range between (3-5)% for fixed residential buildings and prefabricated buildings by (7.5-10)% and mobile homes of 15% annually year(Ministry of Planning,1990). the fact that the(ICF) technique house proposed in this study applies the so-called fixed buildings, the annual depreciation rate that will be adopted for it is (3-5) % ,and(7.5-10)% for (GRC) and(FRP) technique house because they are prefabricated buildings. That means the economic life depending on the rate of depreciation and by the equation(Robert and other,2005)

$$N = \frac{1}{D} \qquad (2)$$

Where:
N: the economic life
D: the depreciation %
are (20-33) year for(ICF) technique house and(10-13) year for (GRC) and (FRP) technique house.
Table(11) shows a simple comparison between the three techniques in terms of initial cost/m^2 and economic life.

Table (11)Comparison between modern techniques

Technique	GRC	FRP	ICF
Initial Cost/m^2	472000 ID	639000 ID	449513 ID
Economic Life	10-13 year	10-13 year	20-33 year

It is clear that the(ICF) model is the best models in terms of initial cost and economic life, in addition to its other properties that have been mentioned earlier , so the researcher will be proposing as an alternative technique to traditional techniques.

11- Construction Mechanism (ICF) Technique

A residential house consists of two floors, Ground Floor 143 m^2 and total construction area of 226 m^2 is built according to the core system using cork and reinforced concrete for walls and ceilings.

this technique is based on a set up forms from cork material manufactured specifically for this purpose in standard sizes and shapes are arranged and installed this forms in places allocated and cutting Places the doors and windows in sizes and shapes that designed the building in very high flexibility. the reinforcing bars are interference within the forms are installed and connected in places allocated to them , Then the concrete is poured into the mold to form concrete walls and bearing by rises required.

The figure (2) illustrates the mechanism that interdependence of the main structural elements (form + reinforcing +Concrete) in the establishment of the walls

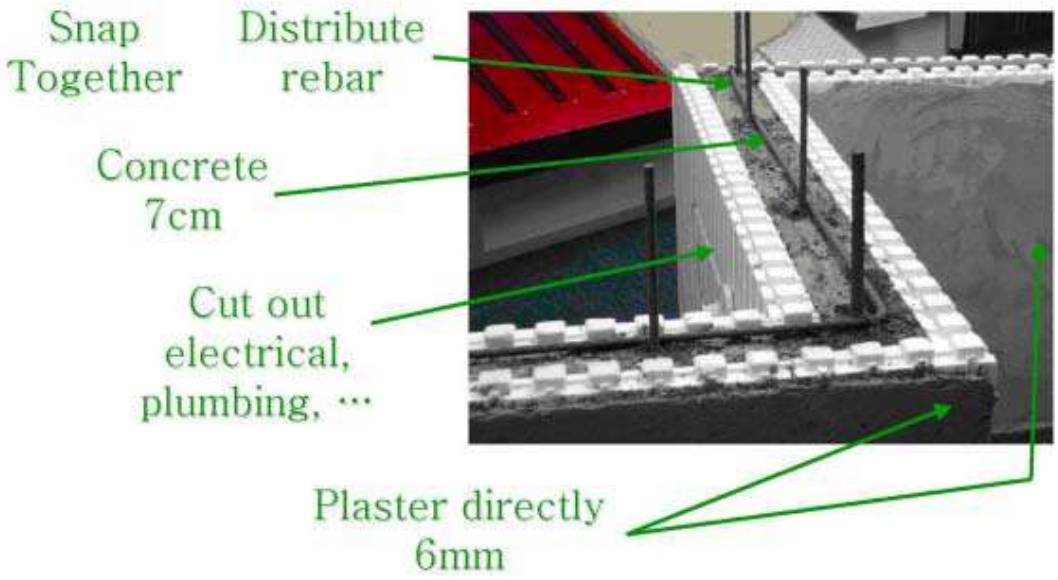

Figure (2)the main structural wall elements

After casting of external and internal walls of the building is complete the process of construction and establishing ceilings which in turn is an economic process and fast in (ICF) technique Install iron clips (T section) to the ceilings By design dimensions then installed the forms of ceiling And the installation of reinforcing steel ceiling According to the approved designs and loads in the design followed by pouring concrete ceiling .This construction technique provides very great flexibility in laying of services pipes in the ceilings as needed, Where all it takes is do openings required laying pipes electricity or sanitation in places through the design form to allow the passage of these services.

After a complete network reinforcing ceilings and extending services pipelines, ceiling concrete is poured over the form for the implementation of the required ceiling.

As for the services pipeline is up in the same way of traditional system with greater flexibility in passing through walls and ceilings when needed by placing through holes in places are required through cutting and then completely covered when the casting process.

After the completion of the basic structure of the building begins finishes stages where the advantage of (ICF) technique characterized it accept different types of internal and external finishes like plaster, cement and ceramics, as well as finishing of modern methods such as gypsum boards for walls and ceilings, as well as false ceilings and stone packaging, etc.

12-Compared to costs

For the purpose of a comparison of the cost of the alternatives building were adopted typical case studies of residential units implemented by the Public Authority for Housing, where three designs for different building systems.

Calculated the cost per square meter of the first and second design, and then the proposed system is compared with traditional two modes(massive and frame wall system),by calculates the cost of the third design if it was built with all of the systems mentioned.

The following is a brief description of the alternatives mentioned:

12-1- Alternative 1 (The First Complex in Kut (Om Helana)Project)

A residential building of 3 floors and 12 apartments and apartment space per 135 m^2, built by massive system using the concrete block walls and reinforced concrete ceilings. The project consists of: 504 apartments Type (A and B) with service (Market, School 3, a health center, a mosque, service department, guard room 2) with all services.

Table (12)Alternative 1 Information

the year	2009
The Location	Kut
Implementing Agency	General Authority for Housing
Implementation period	3years
Total area, built by the project	57dunums
The final cost of the project	40815317070 ID
Construction System	massive system
Type of Contract	Turnkey
The number of residential buildings	42
The cost of residential building type A	814983492 ID
Total construction area of residential building type A	17000m^2
The cost of residential building type A/2	479402
The number of residential buildings TypeA	25
Number of floors type A	3
The number of housing units type A	300
Area of the housing unit typeA	135m^2
The cost of residential building type B	723294100 ID
Total construction area of residential building type B	1500m^2
The cost of residential building type B/m2	482196
The number of residential buildings TypeB	17
Number of floors type B	3
The number of housing units type B	204
Area of the housing unit typeB	120m^2

12-2 Alternative2 Residential complex in Babylon (Ksosuellem2) Project)

A residential building of 4 floors and 8 apartments and apartment space per 155 m^2, built by frame system using reinforced concrete structure and brick partitions. The project consists of: 528 apartments with service buildings(Kindergarten, nursery, primary school, middle school, a health center, administration building, Department resident engineer, guard room) with all services.

Table (13)Alternative 2 Information

the year	2008
The Location	Babylon
Implementing Agency	General Authority for Housing
Implementation period	4years
Total area, built by the project	57.1 dunums
The final cost of the project	589273342308 ID
Construction System	frame system
Type of Contract	Bill of quantities
The number of residential buildings	66
The cost of residential building type A	751521000ID
Total construction area of residential building type A	1425m^2
The cost of residential building type A/m2	527383
The number of residential buildings Type A	66
Number of floors type A	4
The number of housing units type A	528
Area of the housing unit type A	155m^2

12-3- Alternative 3 the proposed technique

A residential house consists of two floors, Ground Floor 143 m2 and total construction area of 226 m 2 is built according to the core system using cork and reinforced concrete for walls and ceilings.

13- Compared to the initial cost

The case studies were selected from projects completed in 2012, but were priced in the years leading up to 2012, while the proposed alternative has been implemented and completed in 2012, so has been modified prices alternative 1 and 2 according to the levels of inflation that have been obtained from the official website of the central bank of Iraq.

Table (14)adjusted price of alternative 1(Researcher)

No.	year	Price ID	Inflation%	adjusted price ID
1	2009	479402	7.1	513440
2	2010	513440	3.1	529357
3	2011	529357	6.5	563765

Table (15)adjusted price of alternative 2(Researcher)

No.	year	Price ID	Inflation%	Adjusted price ID
1	2008	527383	11.7	589087
2	2009	589087	7.1	630912
3	2010	630912	3.1	650470
4	2011	650470	6.5	692751

Also, the prices that have been analyzed for the alternative1 and 2 is the pricing of contractors, while the real cost was calculated for the proposed alternative, so it was a 15% discount from the contractor pricing represents the profit margin and taxes to get the Comparative cost of the alternative1 and 2.

Table (16)Comparative cost of alternative 1and 2(Researcher)

alternative1	Price ID/m2	Discount	Comparative cost ID/m2
1	563765	15%	479200
2	692751	15%	588838

initial cost=the cost per square meter × total area (3)

Table (17) Compared to the initial cost(Researcher)

alternative1	Area / m^2	Cost ID/m2	Total Cost ID
1	226	479200	108299200
2	226	588838	133077388
3	226	449513	101589900

14-Economic Indicators

have been adopted indications cost for comparison on the basis of the fact that benefit equal no difference among the all alternatives, to the fact that benefit assumed is to secure housing for the family but alternatives construction different aims and contribute to access to housing units and low cost. Either index, which will adopt is the net annual cost, so for ease of comparison due to the economic life contrast between the proposed alternatives.

14-1- Economic Life

Due to the fact that the housing units are similar in terms of finishes and services, but the difference is in the structural system, the following percentages will be calculated according to different alternative(Ministry of Planning,1990).

1-Alternative 1: massive wall construction is allocated a lower annual depreciation of a rate of 4%.

2-Alternative 2: frame wall construction annual depreciation rate will be adopted 3% for the high sustainability of this system.

3- Alternative 3: core wall construction annual depreciation rate will be adopted 3%considering that the construction material used is the same as in the structural system and durability are similar, because of the lack of studies determined service life of such a system.

these ratios may increase or decrease and affect positively or negatively on the economic life of the housing unit and its book value at the end of its economic life by different in degrees of quality control of the processes construction, as well as different degrees effectiveness and type maintenance procedures during the economic life and depending how and nature of the use of these units during the economic life.

have been identify the economic life of the three alternatives depending on the rate of depreciation adopted and referred to in 1, 2 and 3 and by the equation(2)

Table (18)Economic life(Researcher)

alternative	1	2	3
D %	4	3	3
N/year	25	33	33

14-2- Annual maintenance cost

The basic cost of preventive maintenance for residential units vary depending on the quality and accuracy of the initial construction and accuracy of maintenance work in addition to the nature of the use of these buildings. Because of the difficulty of identifying regular annual maintenance costs for the lack of previous studies in this field will take this cost is equal to the depreciation ratio of the cost of origin approved by the foundations and instructions of technical and economic feasibility studies development in Iraq.

14-3- Cost recoverable after the end of the economic life

Due to the lack of value for the sale of materials resulting from the destruction work and re-construction in the market, it is assumed that the value of these materials does not exceed the cost of destruction, extraction and transport works, so we will not support any amount of recoverable value in the economic analysis of the three alternatives.

14-4- Interest rate

The adoption rate of interest for the purposes of economic analysis requires study, analysis and survey of the opportunities available alternative in front of low-income and returns this opportunity to invest rather than invest in building affordable housing for them and their families. Of this secured opportunity to this segment of the citizens are the benefits that can be obtained from savings in saving funds and fixed deposit which is 4%.

14-5- Energy costs

Because economic comparison was made in accordance with the architectural design of the house residential which was built by third alternative system, so the cost of energy consumption used in lighting and ventilation, as well as water consumption will be equal, the difference is only in the cost of energy used in heating and cooling, it will be calculated this cost only in economic comparison

According to the design of cooling engineers in the Public Authority for Housing, , this residential house contains 6 devices cooling capacity of 2 tons, equivalent to 3000 W / hr, which is equal to 3 kW/hr, each of the three alternatives

Assuming that each device works 10 hours a day, and that building a third alternative system reduces 50% of the energy used in cooling (Cook,1983), and that the electrical unit price equal to 10 ID / kW according to the official website of the Iraqi Ministry of Electricity, The annual costs for each of the three alternatives will be as in the table (19).

Table(19)Energy costs in ID(Researcher)

Alternative I	Alternative 2	Alternative3
648000	648000	324000

15- Way to make economic comparisons of the three alternatives

The economic comparisons that were made between the three alternatives, which included the previously mentioned factors,

as initial amounts necessary of the implementation of the three alternatives, then enter the evaluator economic life for each of the three alternatives, the interest rate and finally the estimated amounts of maintenance and energy costs that will be spent later in each year of the age of the building, All those factors have been a comparison according to the following method:

15-1- Annual Cost Method

By converting its current value amounts to annual payments according to the following equation(Robert and other,2005).

$$(A = P\frac{(1+i)^n i}{(1+i)^n - 1} \quad 4)$$

Where:
A: Annual Cost
P: initial cost
i: Interest rate
n: economic life

Table(20)economic comparisons of the three alternatives by annual cost method in ID(Researcher)

Alternative	1	2	3
initial cost	108299200	133077388	101589900
economic life	25	33	33
annual cost	6932232	7332863	5597604
Depreciation	4%	3%	3%
Annual maintenance cost	277289	219986	167928
energy costs	648000	648000	324000
total annual cost	7857521	8200849	6089532
total annual cost/m^2	34768	36278	26945

16- Analysis of results and discussion of economic comparisons

Showed the economic results of the comparison between the three alternatives by the annual cost method ,that described in table(20) , according to the parameters and assumptions adopted in the research that the selection of the proposed alternative (ICF) technique is better economically to an economic life of (33) years and then followed by the first alternative (massive wall system) as for frame wall system is the highest cost of alternative of three alternatives.

17- The Conclusions

1-According to cost study and economic comparisons between alternatives that construction by (ICF) technique for an economic life of (33) years is the best of all alternatives economically.

2- The cost of conventional alternatives analyzed in this research is the cost of units within the residential complexes while the cost of construction by (ICF) technique has been calculated for single residential house, nevertheless economic comparisons show that construction by (ICF) technique is the best alternatives economically. On this basis, it is concluded that the construction of residential complexes with this technology will further reduce the cost.

3-It is ease of implement of (ICF) technique without the need for a very high technical expertise and the necessary materials are available or can be manufactured locally at affordable prices.

4-There is great flexibility in the implementation of the housing units by (ICF) technique in different forms, dimensions and heights as desired by the consumer, taking into account the durability and allowable stresses in design.

5- The use of this technique proved through practice to be safer and less prone to risk for accidents during working due to the fact that the light material does not consist of small and sharp parts like bricks. The technique provides a safety factor and safety of workers.

6-Designs for low-income projects have been improved but alternatives and innovations regarding materials and design have not always been successfully implemented. The selection of building materials had deal with "appropriateness" and "adequacy" regarding local conditions.

7-Technical sustainability, such as energy efficiency, diversification, life-cycle analysis of materials, control, responsibilities, impacts on nature and health, should receive more attention.

18- The Recommendations

According to the conclusions can inclusion of a number of the recommendations that contribute to promote and achieve the goals of research and adoption of its results which**:**

1- Implementation of residential buildings at high altitudes to reduce the cost foundations, taking into account the strength of the soil and other design parameters**.**
2- Use of lightweight concrete in the implementation of the walls and ceilings with this technology to reduce the weight of the building and reduce the cost**.**
3- Encourage the private sector of the factory owners to go to the production of components used in the implementation of this technology, such as cork boards , cement boards and other, moderately priced encourages citizen in the popularity of this technique**.**
4- Contribution of universities and research centers for construction by giving attention and encouragement to conduct research for the production of affordable housing units helps low-income people to get access to proper housing units suitable for families, contributing to significant fill the gap in housing units in Iraq**.**
5- Contribution of stakeholders such as the Ministry of Construction and Housing to the implementation of models for residential units presented to the citizens for their information, using new materials and systems, with the definition of citizen benefits of these new systems in terms of efficiency, quality and cost**.**

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