

**High Performance Cost-Effective Buildings
with
Kayson's Cast-in-Situ Monolithic Reinforced
Concrete Construction System**



Foreword

Housing standards and construction methods are by no means static. In fact, they are constantly evolving to reflect diverse and changing economic conditions, social values, traditions, and technological advances.

The Cast-in-Situ Monolithic Reinforced Concrete Construction System is Kayson's integrated solution to the problem of large-scale residential housing development. It is widely recognized as one of the most practical, economically and technically feasible solutions to the problem of building cost-effective, descent, durable and earthquake-proof housing on a mass scale, quickly and efficiently. Indeed, Kayson's unremitting efforts over the past thirty years to adapt the system to varied topographical and climatic conditions has resulted in the development of a unique method for building large scale housing faster, better and at a lower cost, in virtually any corner of the globe.



Overview

Prior to describing in detail Kayson's mass housing system, it is appropriate to outline some of the main features of industrialized housing construction:

- Industrialized construction is not necessarily synonymous with prefabrication.
- The most important characteristic of industrialized construction is the use of advanced machinery and equipment and trained workers to increase the speed of construction, improve quality and optimize the utilization of resources.
- Since in industrialized construction the builder has to use extremely expensive types of equipment and machinery, he has to make a much larger initial investment than is the case in traditional construction methods. It is obvious that such a big investment only pays off in large-scale, mass production.



Major Characteristics of Kayson's Formwork System

- The Cast-in-Situ Monolithic Reinforced Concrete Construction System utilizes a large steel formwork system.
- Notwithstanding their size, the forms are easy to install, more durable, more precise and produce higher quality structures. What is more important is that Kayson's formwork system enables the builder to repeat the entire construction cycle within a period of merely 48 hours.
- The Cast-in-Situ Monolithic Reinforced Concrete Construction System uses a formwork system that allows the contractor to cast foundations, walls, and ceilings according to a pre-defined cycle. It combines the speed; quality and accuracy of factory/off site production with the flexibility and economy of in-situ construction. The result is a reinforced concrete structure, the surfaces of which are of sufficiently high quality to require only minimal finishing for direct decoration, while the end walls and facades are easily completed with thermally insulated material that can be clad as required.
- The forms are lighter than most other formwork systems. The weights of wall and ceiling forms are 68 kg and 40 kg per square meter respectively. The average weight of a complete set of forms used in constructing two 84-meter residential units is about 298 kg per square meter of floor space.
- The wall forms can be removed within merely five to eight hours. Each set of forms can be used up to two hundred times, provided it is properly maintained and serviced. This cycle can be repeated following a thorough overhaul of the formwork components. One of the main difficulties encountered by other in-situ concrete systems is the deformation of window frames after the concrete is poured. This problem has been totally resolved, thanks to an innovative method developed by Iranian engineers.





- Ceiling forms are made up of light steel panels with spans of less than 3.5 meters. They are mounted on two rows of rail supported by steel piles.
- In Kayson's formwork system, the problem of fitting the window frames into the forms prior to pouring concrete and the leakage of concrete have been fully solved by developing a unique formwork design which sums up years of experience and practice.
- Due to the forms considerable strength and flexural rigidity fewer nuts and bolts are used to join the constituent parts of the formwork system.
- Kayson's formwork system has substantially less joints compared with other methods. For example, spaces of up to 20 square meters are often covered with a single monolith form.
- The large, yet light, exterior and interior wall forms are quickly mounted by a tower crane and fixed in place and fastened to each other by nuts and bolts specially made for this purpose. In general, a complete set of forms encompassing two 84-meter apartments are installed within five hours.



Design and Construction Stages

- The foundation, the wall, and ceiling formwork systems are designed in strict compliance with the architectural plan.
- The components of the formwork system are manufactured in the fabrication plant in accordance with the design specifications.
- The construction site is leveled and compacted according to the project's technical requirements.
- A layer of lean concrete is applied to the foundation site.
- Sewerage pipes are laid.
- Reinforcement bars of the foundation are installed after the lean concrete gains sufficient strength.
- The foundation forms are installed and poured.
- The wall reinforcement mesh which has already been put in place is connected to the starter bars of the foundation.
- The window and door frames, electrical conduits and sockets, water pipes and sewer ducts are all built into the forms, thereby eliminating the need for drilling, boring and excavation work.
- Ventilator and chimney conduits are also pre-fitted into the forms. There is, therefore, no need to use precast concrete pipes, as is the case in traditional methods, for ventilation and the chimney. The wall forms are then installed and poured monolithically.
- After removing the wall forms, first the ceiling reinforcement mesh and then the ceiling forms are installed.
- The ceiling reinforcement bars are joined to the wall by means of starter bars. At this stage, junction boxes, electrical conduits and water pipe ducts which pass through the ceiling are built into the forms.



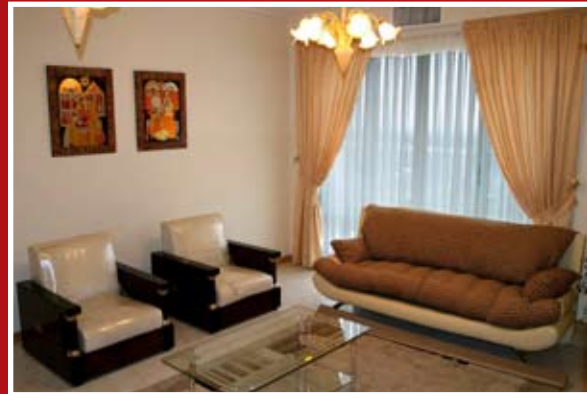
- The ceiling forms of the ground floor are poured monolithically.
- In order to avoid noise nuisance to residents, prior to pouring the final concrete layer of upper floors, a 5-centimeter layer of propylene is applied to the concrete floor of each apartment.
- Then the ground floor ceiling is prepared for the installation of the walls of the first floor. This cycle is repeated in the same manner for other floors.



Structural and Architectural Features

The system creates an efficient load-bearing structure for use in a variety of applications. It is particularly effective in projects suited to repetitive construction, especially large-scale mass-housing projects. The solid, strong monolithic structure can be 2-20 stories in height and the accuracy of the system suits the installation of prefabricated elements such as cladding panels and bathroom pods, offering more Modern Method Construction (MMC) options.

- The entire structure, including the foundation, the walls and the ceilings functions as an integrated whole.
- Since all the constituents of the structure are load bearing, the overall weight of the building is nearly 300 kg per square meter less than steel structures.
- The walls, 10-20 cm. thick, are joined to the foundation and the ceiling slabs by means of dowel bars. The high levels of dimensional accuracy achieved with the continuous formwork system and the superior load distribution result in a strong, solid monolithic structure suitable for a multitude of uses. The system's excellent structural integrity provides opportunities to use non-load bearing internal partitions that can be moved to provide alternative layouts.
- Due to the overall integrity of the structures, problems arising from the use of low-quality materials, such as cracks and foundation settlement, are avoided.
- Since the plan design closely conforms to architectural requirements, it eliminates the need for using traditional load-bearing or modular systems.
- To achieve greater architectural flexibility, some internal partition walls can be built with gypsum boards, panels, or masonry materials.
- One of the most important features of any building is its ability to protect human life and an earthquake is the most demanding condition that any building may be required



to survive during its life time. To survive the nurture's might, safety, and security has also historically posed the greatest challenge to architects and structural engineers. Kayson's in-situ concrete, monolithic system, with its unparalleled structural integrity, provides excellent protection against earthquakes of the highest magnitude.

- The system creates no restrictions as far as finishing work is concerned.
- Although the system is only utilizable in large-scale construction, it gives us the freedom to build a variegated assortment of architectural designs and facades.



Savings in Men, Material, Equipment, Transportation Cost, and Time

- The reinforcement bars used in this system on average weigh 33 kg per square meter, as compared with about 50 kg in conventional methods.
- Not only the speed of construction in Kayson's system is substantially greater than traditional methods, the overall speed of construction can be doubled or tripled simply by adding one or two more sets of forms.
- Since all precast elements are built on the spot and only the forms are manufactured in the factory, there is no need to transport prefabricated parts to the project site.
- In Kayson's system a set of forms is used two hundred times but is transported to the site in a single trip, whereas in the case of prefabricated panels, for instance, they would have to be transported to the project site in 200 trips.
- Construction materials, instead of being transported to the factory where they are turned into prefabricated parts, are shipped directly to the site.
- The in-situ casting of units on site and the availability of ready-mixed concrete supplies reduce transportation impacts.
- Just-in-time deliveries and near zero wastage provide an overall tidier site with associated cost savings and safety benefits plus minimum disruption where the site is already partly occupied.
- If so required, all outer walls can be equipped from the inside with gypsum boards or from the outside with other suitable materials to achieve optimal thermal insulation.
- Our system affords further savings in time and material since it enables us to paint directly on concrete immediately after removing the forms.
- Overall, Kayson's housing construction system costs far less per square meter than conventional methods.



Principal Advantages

- Shorter site preparation and establishment.
- Provides better protection against natural hazards such as windstorm and earthquake, as well as against fire and explosion.
- Extraordinary speed of execution and more effective and precise schedule control.
- Less manpower, particularly unskilled labor, and more efficient personnel management.
- Easily adaptable to diverse topographical and climatic conditions.
- Produces greater savings in men, material, equipment, transportation costs and time.
- Offers more possibilities for variety in architectural design.
- Readily lends itself to quality control and assurance.
- Ensures a longer useful life.
- Costs substantially less than conventional methods.
- Easier cost control, and more accurate cost forecast.
- When appropriately insulated, the concrete mass of walls and floors provides an enormous heat sink and stores energy for later use. While this thermal mass/heat storage concept is well understood in terms of reducing winter heating costs, its reverse summer effect is not so well known: the thermal capacity of concrete ceilings and walls reduces peak temperatures during summer by around five degrees Celsius, providing a more comfortable environment during hot weather.
- The repetitive, predictable nature of the tasks involved encourages familiarity with operations and, once training is complete, as construction progresses, a zero accident objective becomes more and more achievable. The minimum requirement for tools and



equipment when moving the forms further reduces the risk of accidents on site.

- Concrete is an inert material that is easily recyclable. Old concrete that has reached the end of its service life can be reused as aggregate for new concrete mixtures. Another environmental benefit derived from a concrete frame is that all the steel reinforcement is usually manufactured from recycled material.

- All service runs can be pre-installed before the concrete is poured. Other facilities such as bathroom fixtures can be installed quickly as work progresses on other floors.

- Concrete's thermal mass coupled with correct insulation minimizes heating costs and can reduce air conditioning requirements, with the resultant benefits for the environment. The monolithic and accurate structures facilitate airtight construction, an expected requirement in all building regulations.

- Interior walls built with Kayson's housing system reduce the movement of airborne sounds from one room to another, thereby enhancing privacy.

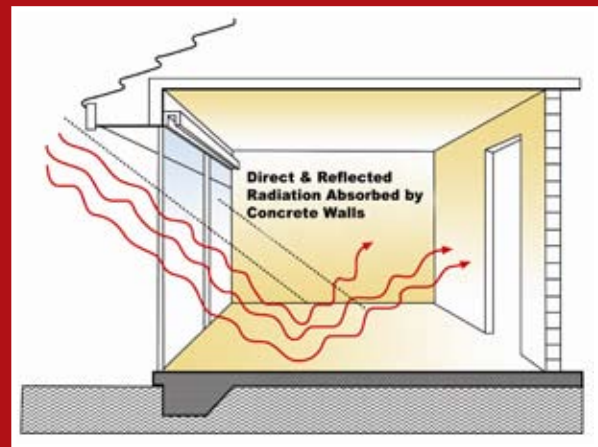
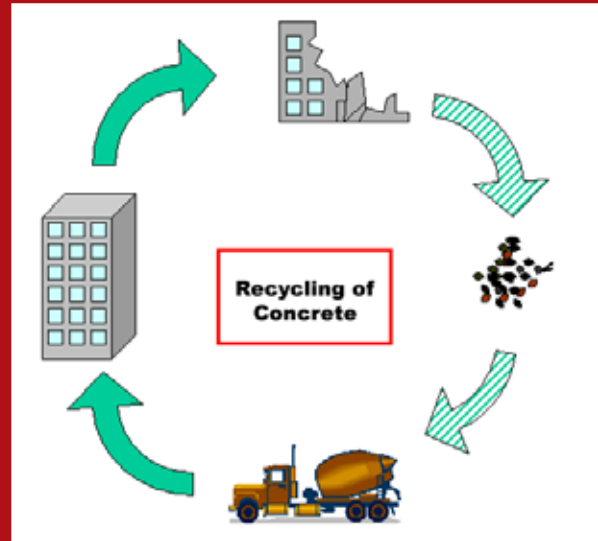
- Direct finishes and durable walls minimize decoration, repair and refurbishment costs. Wall paper can be directly applied or a skim coat may be used to provide a perfect plastered finish.

- Kayson's system is extremely user-friendly. That is, the nature of the system is to create a rhythm for the worker. By taking advantage of the 48-hour cycle, the same steps in construction are repeated over and over again. If the site staff is inexperienced with the system, on-job-training quickly brings them up to speed. The result is a workforce that can work effectively together as a highly productive team.

- In the 10,000-unit housing project in the Bolivarian republic of Venezuela, Kayson engineers trained nearly 4000 unskilled workers in a matter of merely three months.

- Concrete is often left exposed on interior walls due to its aesthetic appeal, durability and inherent fire resistance. Exposed concrete reduces the need for and cost of applying additional fire-proofing to satisfy building codes.

- A major advantage of concrete construction for engineered structures is the material's properties of density and mass. Lateral stiffness, or resistance to horizontal movement, make concrete the product of choice when constructing in areas where high winds, hurricanes, tornadoes or seismic conditions are considerations. This lateral stiffness also means occupant of concrete structures are less able to perceive building motion.



Integrated Total Quality Management

In Kayson's system, all phases of construction process are controlled with exacting accuracy by implementing an integrated total quality management system. Indeed, without such system it is impossible to integrate and industrialize the construction site. This system encompasses design, engineering, procurement, construction, quality assurance and quality control, value engineering, human resource management, logistics, as well as environmental protection and occupational health and safety. Such comprehensive integrated approach to mass housing construction radically improves the quality, durability, safety, environmental performance, energy efficiency and affordability of homes built by Kayson. We also evaluate the efficiency of our quality management system through regular audits, the results of which become part of our continuous improvement systems.

A key element of our total quality management is customer satisfaction. Shortly after construction begins, a strategic communication plan is drawn up which includes such action items as distributing project brochures and newsletters about the project, holding informational events, launching an information-packed website, and inviting clients, local people and potential end-users to visit the site.





Kayson's Industrialized Mass Housing System A Fast and Cost-Effective Solution to Global Housing Crisis

The problem of inadequate or non-existent housing has reached global proportions. The world population passed 6.1 billion in 2001 and is expected to exceed 9 billion by 2050. This sheer volume exerts enormous pressure to create new homes.

Some 70 million people mainly in Asia, Africa and Latin America move from rural villages to urban communities every year. Moreover, a large number of existing homes are extremely vulnerable against earthquakes, hurricanes and other natural disasters. To avert a massive urban crisis in the near future, governments will have to take the lead in constructing some 35 million housing units per year, requiring an annual investment outlay of over one trillion dollars. Therefore, the scope of the global housing crisis demands fast-track cost-effective solutions. Looking at other industries such as cars and electronics, it becomes clear that industrialized mass production is the most effective way to get the most goods to the most people for the lowest cost in the least amount of time. Kayson's housing system makes this possible by turning the construction site into a highly efficient mass production line. In the 10,000-unit housing project we recently built in Venezuela, this system enabled us to construct the reinforced concrete structure of 24 housing units per day. In a 20,000-unit mass housing project, we just commenced building in Iran, we plan to build 56 units per day.



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