26 Apr 1972

The Logic of a Solution

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THE LOGIC OF A SOLUTION

by

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Lower cost housing has been the goal of many and has resulted in a variety of attempted solutions. Frequently the solutions have been ingenious but have foundered because they have not been integrated into the task of conceiving, creating, constructing and delivering a total project. This integration requires an organization with a wealth of experience in design, construction, financing, development, sales and management. With such capability a good idea can be made to work wherever a market can be created and sustained.

Organized with a mind to total packaging, the F.D. Rich Housing Corporation has now introduced a precast concrete box construction technique known as the HABSystem. Other box constructions have been tried recently and they have been given the generic name of "Building Blocks of the Twentieth Century". Some have met with success, others have not gotten off the drawing boards. All have envisioned minimization of field work.

The uniqueness of the HABSystem stems from its utilization of the boxes as beams, spanning the width of a building. Supporting columns are located in rows, front and back. In this way a standard box can be utilized in high rise building construction of theoretically any height by using appropriate column sizes. Varying the space between adjacent boxes is one way of doing this for different building heights. Most other box techniques are box bearing systems in which upper boxes bear on lower ones. This sometimes creates certain structural and height limitations.

By spanning across the width of the building, the box beams are suspended in air. They are thus conveniently arranged so there is a plenum space completely surrounding each unit. The encapsulating plenum offers the opportunity of incorporating air handling features, providing heat sinks for fire resistance, and creating physical space for intermodule connections. Finally, the encapsulating space offers the opportunity to house a variable reinforced concrete structural framework which, coincidentally, creates the plenum space and is required to lend rigidity to the structure since the box modules are in of themselves thin shells of lightweight concrete to allow for high lifts in field erection. The structural framework, placed at the site, is installed relatively easily by utilizing the boxes themselves to self-form the column and beam configurations. A fire-stopping, again, simply installed, is also incorporated at each floor level. Some details of the system (patents pending) are shown in Figures 1 and 2.

With boxes entirely independent, one from the other, no interior surface is exposed during transportation as occurs, for example, when boxes are used in checkerboard fashion with a floor slab serving simultaneously as a ceiling for a room below. Accordingly, the interior of a box is finished completely at a factory location, then sealed and the module is thus shipped to the site without endangering the integrity of the finish. Since all plumbing, wiring, painting, floor covering, etc., is incorporated at the factory, the module can literally be sealed to prevent entry of field personnel into habitable areas, save for the final punch list inspection. The vertical connections between modules are made in the field in a single utility room provided to house individual apartment mechanical services. The utility room is exterior to the living spaces within the module.

The system described might be called a flexible "closed"

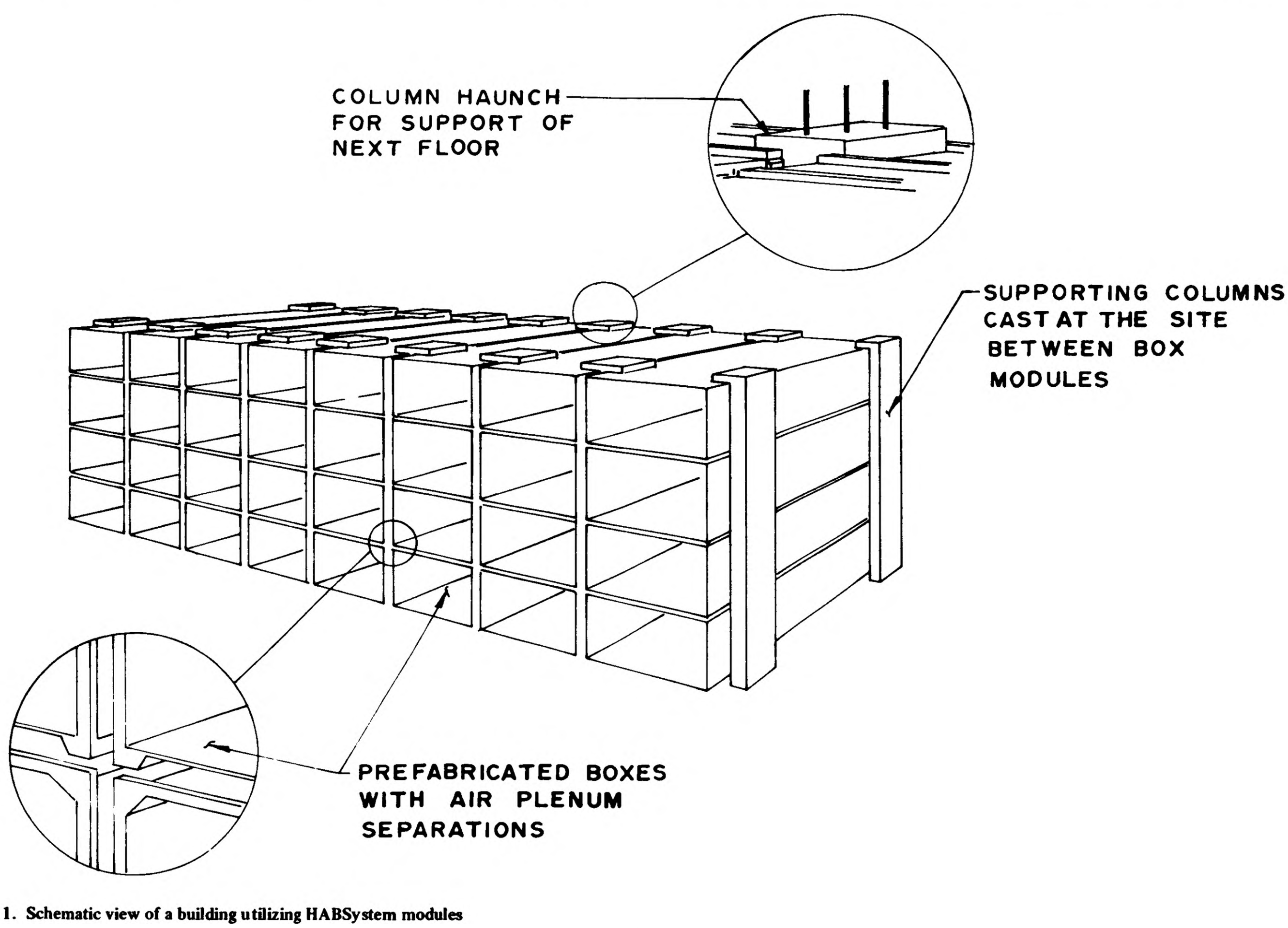

Fig. 1. Schematic view of a building utilizing HABSystem modules

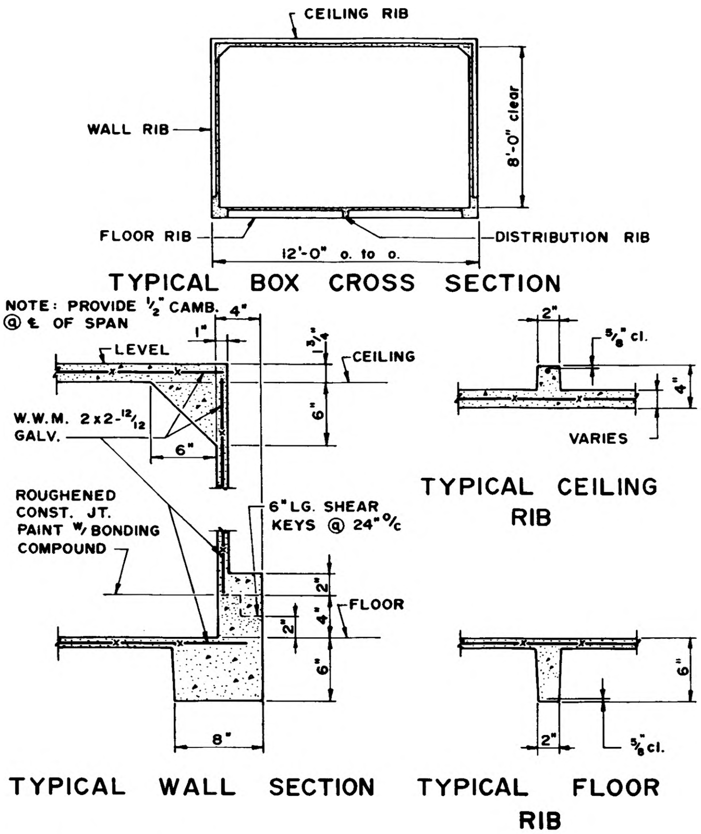

Fig. 2. Box beam details

system. The advantages and disadvantages of "open" and "closed" systems have been discussed at length in technical literature. Frequently, the automobile industry is the metaphor for systems analysis. A system may be closed for the bulk of the production but permissive of features which, at cost differentials, can significantly alter the appearance and convenience of the product. For the purpose of meeting specific market demands, the HAB-System follows this principle closely. The basic unit of production is intended to provide what are generally considered to be minimum acceptable housing standards for the United States; that is, those prescribed by the Federal Housing Administration's "Minimum Property Standards". These minimum standards can be met for 0, 1, 2 and 3 bedroom units. A typical floor plan of such a facility is indicated in Figure 3. Modified, the boxes can provide a more spacious duplex apartment as indicated in Figure 4. The duplex apartment could be further enhanced with more elegant architectural facades. At both ends of the scale, and in situations in between, the basic shell remains the same. The analogy between the economy model and the custom automobile remains valid.

The fact that the structural system creates a plenum provides an opportunity to supply total interior thermal control at very little cost. As can be seen from Figure 5, conditioned air is pumped

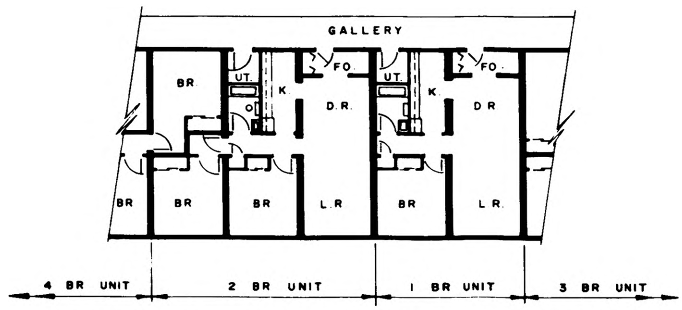

Fig. 3. Floor plan supplying minimum standard requirements

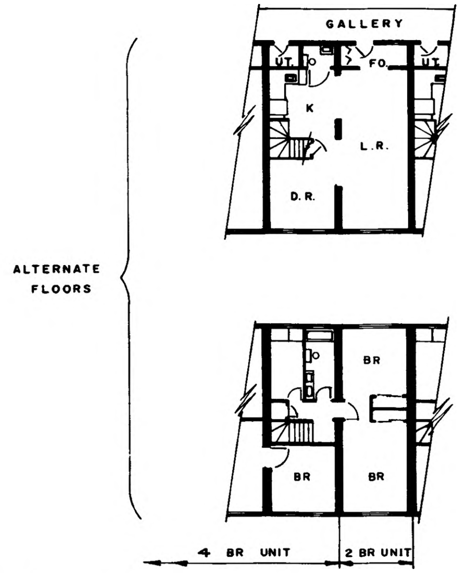

Fig. 4. Floor plan of a duplex apartment with increased habitable area

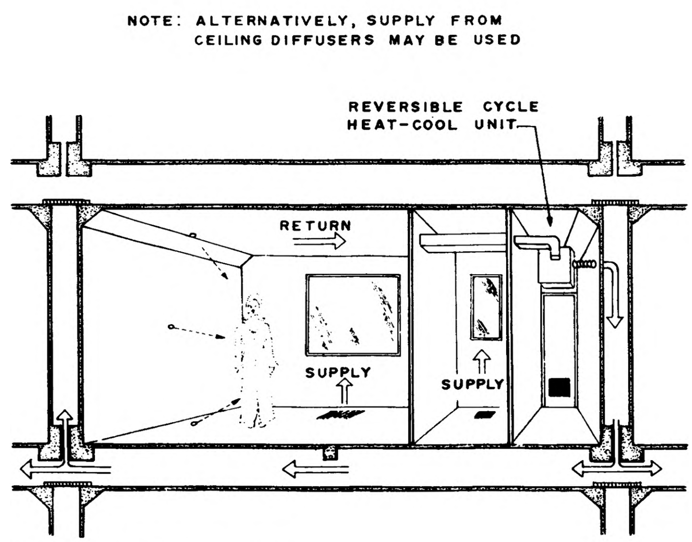

Fig. 5. Air distribution in the HABSystem

into the plenum space from a reversible cycle unit located in each utility room. The conditioned air (heated or cooled) washes the walls, floors and ceiling surfaces of the concrete box and then escapes from the plenum through diffusers into individual rooms and finally returns to the heating-cooling unit via a return air duct. Studies have shown that the concrete wall, ceiling and floor act as radiant plates, and approximately 50% of the thermal delivery is by radiation and the remainder by air delivered by convection. As a result of radiation, thermal distribution in habitable areas is stable and uniform.

While this system provides a high degree of environmental control for low cost housing, an examination of the details of construction will indicate that the cost of the system is relatively inexpensive. Cost considerations are limited to the factory installation of the heating-cooling unit and central accessories. All distribution is provided by the plenum spaces formed by the separation of the modules which, in turn, resulted from insertion of a structural system.

In developing this system, some specific problems and solutions were encountered in a pilot run of a factory for the construction of two small projects and are illustrated in Figures 6 and 7. Figure 6 shows a shuttle system devised for the purpose of producing one module per day per set of molding equipment. The tunnel form is seen engaged in the casting process for walls and

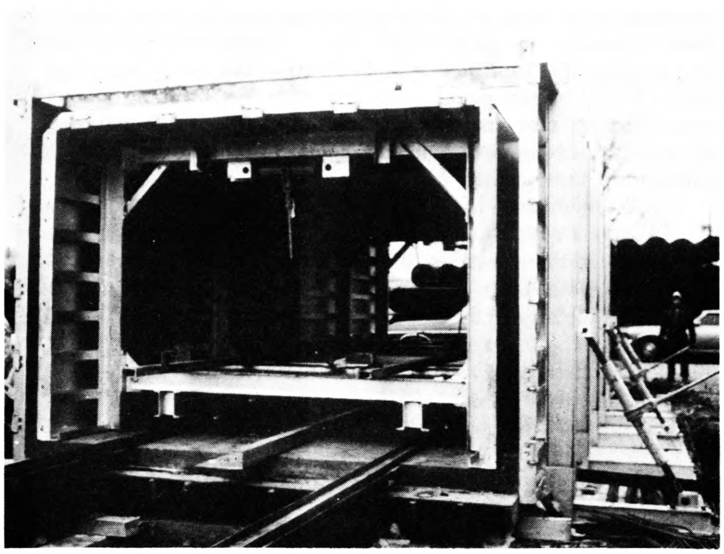

Fig. 6. Mechanized moulding equipment for box construction

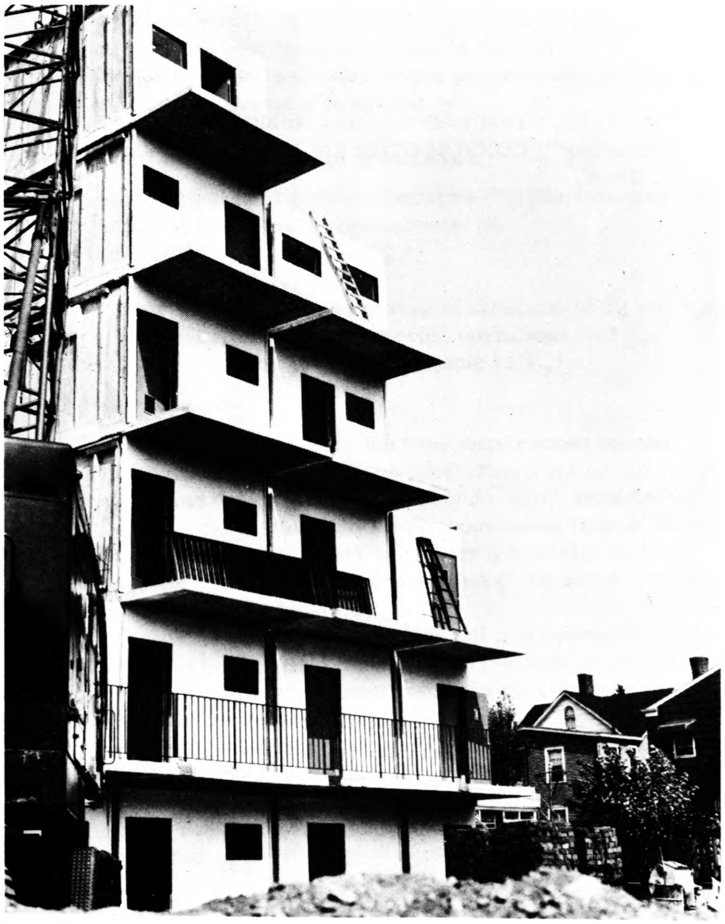

Fig. 7. Field erection of modules

ceilings at Bed No. 1 while simultaneously at the other end of the track (not seen in the photograph) casting of a floor on Bed No. 2 can proceed. That floor will be ready to receive the tunnel form on the following day, at which time the described cycle is repeated. This operation requires the production of high strength concrete in relatively short periods of time. This problem is further aggravated by the special demands created by the employment of very thin floor, wall and ceiling sections. For the purpose of reducing the weight of the prefabricated modules, these sections sometimes are as thin as one inch. Further, for the purpose of increasing the fire resistance of the construction, expanded shale aggregates are employed. Special demands are placed upon the material technology of the concrete industry to meet these requirements. At premium costs, when necessary, the most modern developments in concrete technology can be utilized to increase production rates to two boxes per day per set of molding equipment.

This requires obtaining high strength concrete capable of being demolded and transported within a period of eight hours. Tests have been conducted to establish the validity of the materials used. Such tests include both laboratory specimens, full-scale strength tests of modules, and standard ASTM fire tests. Additional tests have been conducted to establish impact noise resistance and sound transmission ratings of full-scale modules.

The use of very thin floors, walls and ceilings, stiffened by external ribs, does not impinge upon the strength and versatility of the module in its ability to stand as a box beam between columns cast at the site. This versatility is illustrated in Figures 8 and 9 which illustrate some of the major penetrations permissible in the box construction. These penetrations, fully justified by structural analysis and full scale field tests, permit considerable latitude in the development of a variety of interesting interior layouts.

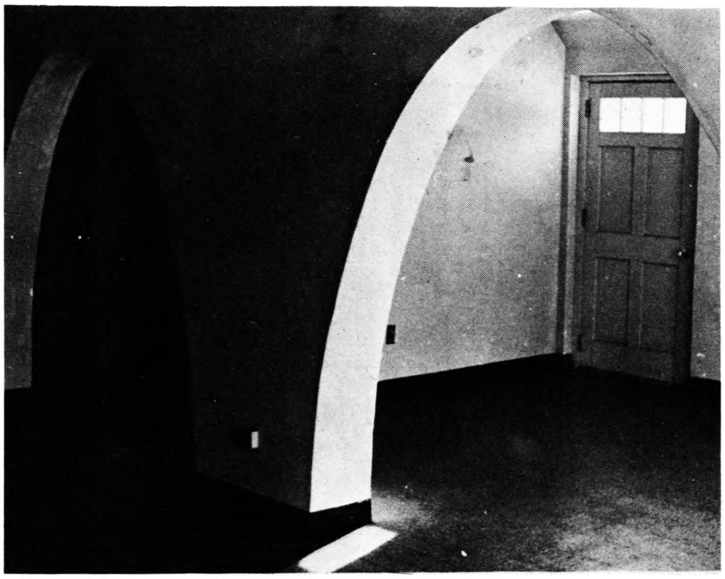

Fig. 8. Individualized archways for custom designed rooms

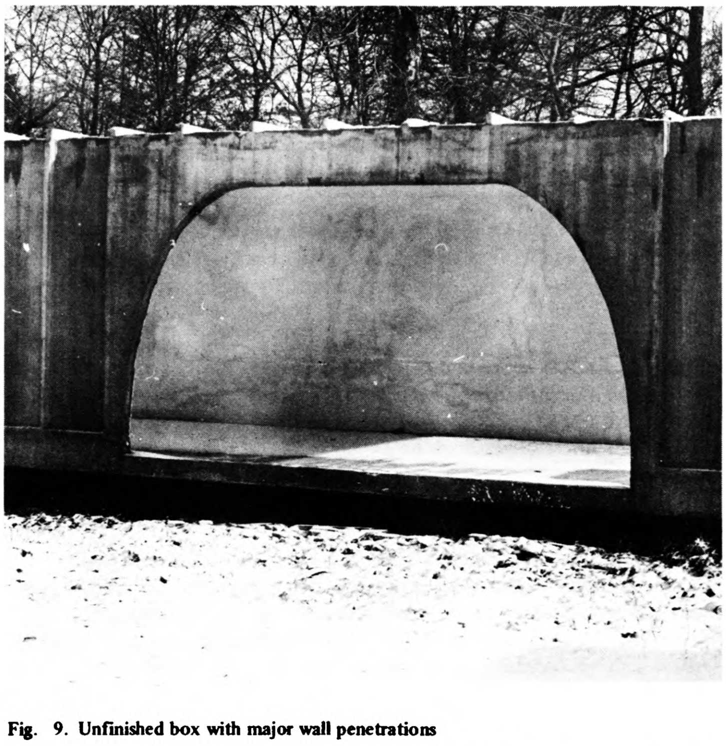

Fig. 9. Unfinished box with major wall penetrations

It should be emphasized that the box modules are suitable for use off-the-shelf on any standardized apartment layout. Building dimensions in height and length do not have influence on the module to be used. Those dimensions influence only the size of structural framework inserted at the site. It can be seen in Figure 10 that column reinforcing and dimensions can be easily changed in width and length with very little cost ramifications. The basic factory-produced module remains unchanged throughout the structure

Fig. 10. Construction view of reinforcement for front and back columns

regardless of building height or architectural utilization of the variable framework. In this connection, computer programs are being developed to facilitate standardization and easily compiled designs for all building configurations. The HABSystem is equally versatile in low rise and high rise configurations. Accordingly, total housing development concepts remain completely flexible to architectural individuality and layout.

For any system to actually contribute to the delivery of housing for persons of low and moderate income, not only must it be flexible enough to operate within a current and ever changing socio-economic context, but more importantly, the system must be sponsored by an organization capable of orchestrating a variety of normally independent disciplines including architecture, engineering, contracting, financing, real estate, sales, marketing and industrial production.

The coordination and implementation of this variety of disciplines has been called Systems Contracting. (1) This paper has made no attempt to investigate the implications of Systems Contracting as applied to HABSystem; however, regardless of the details and hardware of the individual system, for it to be an effective contributor to the national housing supply, it must be a working part of a System Contracting effort of a broadly based housing organization.

REFERENCES

1. Rich, F.D., "Profitable Systems Buildings Requires Systems Contracting", CONSTRUCTOR Vol. LIII, No. 1, Jan. 1971, pp. 34-36.