

ARCHITECTURAL RECORD



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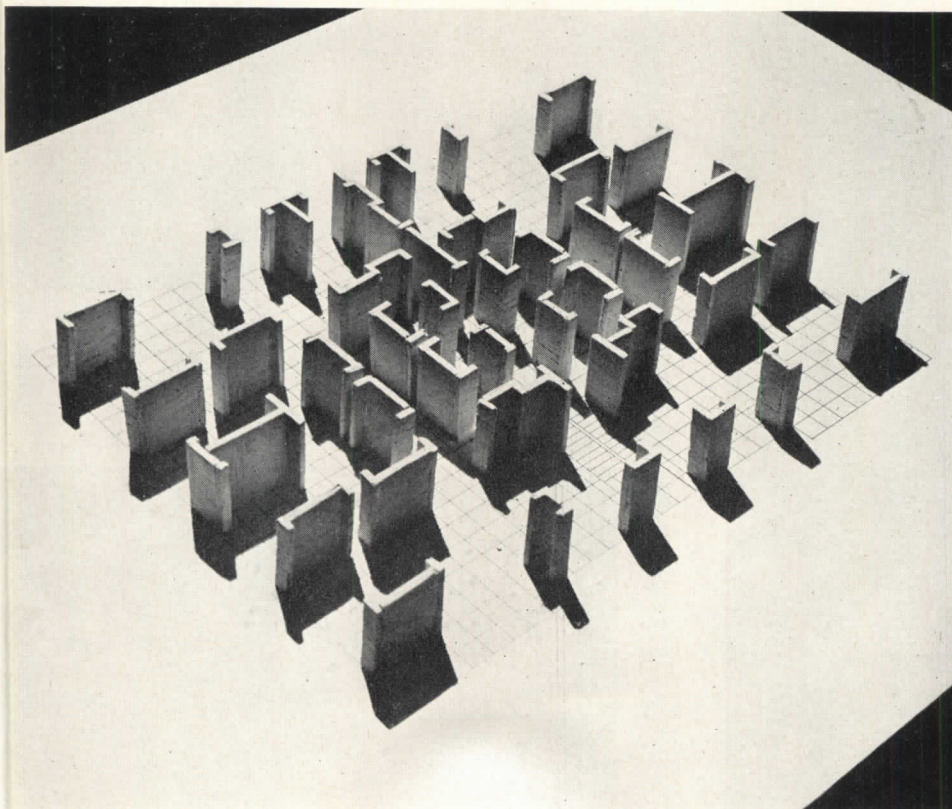
PARTITIONS FUNCTION AS COLUMNS

In Scheme For Apartment Buildings

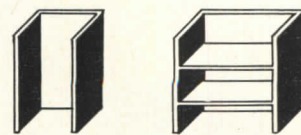
Olgyay and Olgyay, Architects, Notre Dame University

Bela Kiss, Structural Engineer, Budapest

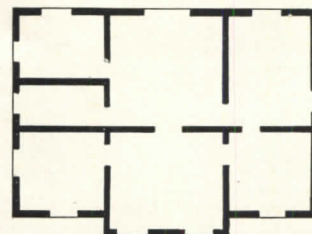
Comments by Paul Weidlinger



Model of floor in walk-up-type apartment pictures how concrete partitions work as columns



Various types of partitions



1.

THERE is a growing tendency in some phases of building, just as there has been in the aviation and automotive industries, to depart from "frame and enclosure" types of structures. That is, those structures which separate load-bearing elements from the rest of the construction. For example, "stressed skin" type of construction employed in airplanes also has found application in load-bearing plywood walls for prefabricated houses.

Architects, Olgyay, and engineer, Bela Kiss, have encouraged this tendency with their system of multi-story construction: *reinforced concrete partition walls become the supporting elements, eliminating separate columns.* Broken shaped partitions, especially suitable for apartments, and two-way ribbed floors

work together to carry imposed loads.

Efficiency of building construction often is expressed on the basis of ratio of total dead load to utilizable live load — efficiency varying inversely with this ratio. The system of construction presented here, called *cellular* by the architects, is aimed at reducing this ratio to a practical minimum.

Partitions, by virtue of their shape, obtain maximum utilization of strength of materials, following somewhat the idea of light gage steel construction. The partitions are functional otherwise in that horizontal ribs used to stiffen the vertical sections can serve as shelves.

System Originated in Europe

This method of construction is one of the many advanced methods which have

come to us from Europe, where the importance of saving materials has given the impulse to a number of new developments. Innovations, based on an economic system and material and labor cost relationship which are quite different from ours, often are not suitable to adaptation here.

Of many such ideas, only those which represent fundamentally new and sound structural concepts are destined for application in the U. S. The recent successful "Americanization" of prestressed concrete is an example of this. *Cellular* construction, if introduced here, might become the next contender.

What's New About It

It is in many respects a basic development in the spirit of advanced building

technology. These are as follows.

1. It is the next logical step in development of the flat slab, which represented the transition from linear column-girder construction into the three dimensional rigid frame.

With *cellular* construction, the linear, one-dimensional column is replaced by the two-dimensional wall. (It is interesting to note the reappearance of the "load-bearing" partition in its new form.)

2. In the quest for elimination of all

unnecessary weight from structures, full utilization of new building materials of high strength and uniformity has become a problem. Structural elements are now reduced to critical cross-sectional areas; and instead of strength, elastic stability (i.e. the over-all or local buckling of the members) becomes the controlling factor in design. This is clearly expressed, at present, in structural elements and shapes developed for light gage steel, aluminum and also plywood.

The very same problem is faced and solved now in this new method of construction in reinforced concrete. Load-

bearing elements are thin-walled concrete shapes, stiffened to avoid local buckling through stiffening flanges very similar to those of light gage steel studs (see top drawings on this page).

3. Structurally, this system is one which only a decade ago would have been nearly impossible to analyze. Even today, the design of a flat slab with irregularly placed supports requires a complex and time consuming analysis. The design of a slab supported and restrained by irregularly placed thin wall sections is even more complex.

Similarly, the design of concrete wall sections to avoid over-all torsional and local buckling is no simple task. However, the challenge presented by these problems can be met today with advanced methods of engineering analysis, but would not have been practicable a short time ago.

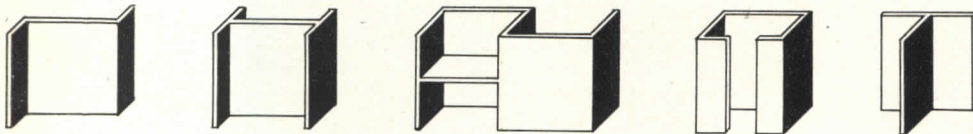
4. Finally, because of the complexity of the engineering analysis, successful application of this system requires the disciplined approach and structural understanding of the contemporary architect. It is a structural system which requires honest architecture.

All these are sure signs that one is faced here with a fundamental innovation which is bound to have beneficial influence on our building technology, if it is given a chance for application in this country. The advantages to be gained are clearly shown in the two apartment house designs that follow: one, an elevator-type and the other, a walk-up type. These buildings were projected originally for the rebuilding program of Budapest, Hungary. The apartments actually built were modified because of the urgency for residential construction and the economic situation abroad.

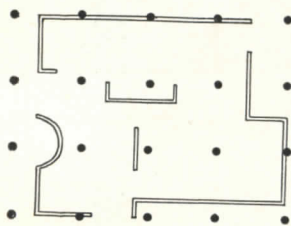
How Apartments Are Built

Concrete partitions are poured in forms (or molds) which remain in the construction; molds serve as internal insulation and outside finish. Before concrete is poured, vertical and horizontal reinforcing is inserted in the molds. The molds are expanded gypsum and lime. Concrete in contact with the molds loses its water content and gets rigid immediately, shrinkage being less than in normal concrete construction. Molds are prefabricated in various shapes to permit precise and easy placement of the reinforcing.

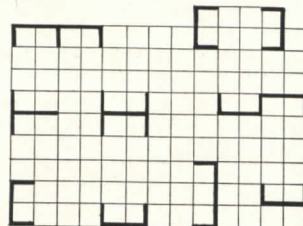
Floors are grids of two-way beams with the open spaces being filled by



designed to get high strength and consequent thinness of section using reinforced concrete



2.



3.

Comparison of conventional framing with cellular construction

1. The load-bearing wall system utilizes all faculties of the material: bearing capacity, space enclosure and insulation value. Between limits it is still the most economical. But above a certain height, it becomes impractical because of necessary wall thickness. At the same time, its cumbersome nature makes free planning quite difficult

2. Skeleton framing yields the essential advantages of economy in floor space, flexible planning and light structure. However, walls function only for space enclosure and insulation. Structurally they are only dead loads

3. Scheme of cellular construction. Vertical concrete slabs in various shapes act both as load-bearing elements and walls. They can be shaped, within a certain discipline to the grid, to fit a desired plan. Floors are two-way beams poured monolithically with the partitions. Structure thus works in all three dimensions. Forms may be permanent, providing both insulation and facing

hollow-core gypsum blocks. First these blocks are laid on formwork, and then concrete for the beams is poured in between. Where partitions are located, the beams are poured monolithically with them.

In a six-storied apartment in Budapest, the load-bearing partitions were built 2 to 3½ in. thick. Spans of the floor grid varied, with 24 ft as maximum.

Care has to be taken in design that the load-bearing partitions are placed in more or less equal "density." Due to the two-way floor grid it is not necessary that they line up. The amount of reinforcing necessary depends on how close partitions are spaced.

Implications for U. S.

Material saving aspects of *cellular* construction should gain added importance in the present economic situation. The feasibility of low cost walk-up apartment buildings in fire-resistant construction should be welcomed by all, including city planners and insurance companies. Elimination of all columns means increased floor area. Reduced depth of floor construction means reduced building height. Lightness of structure means smaller footings. All these spell more economical construction.

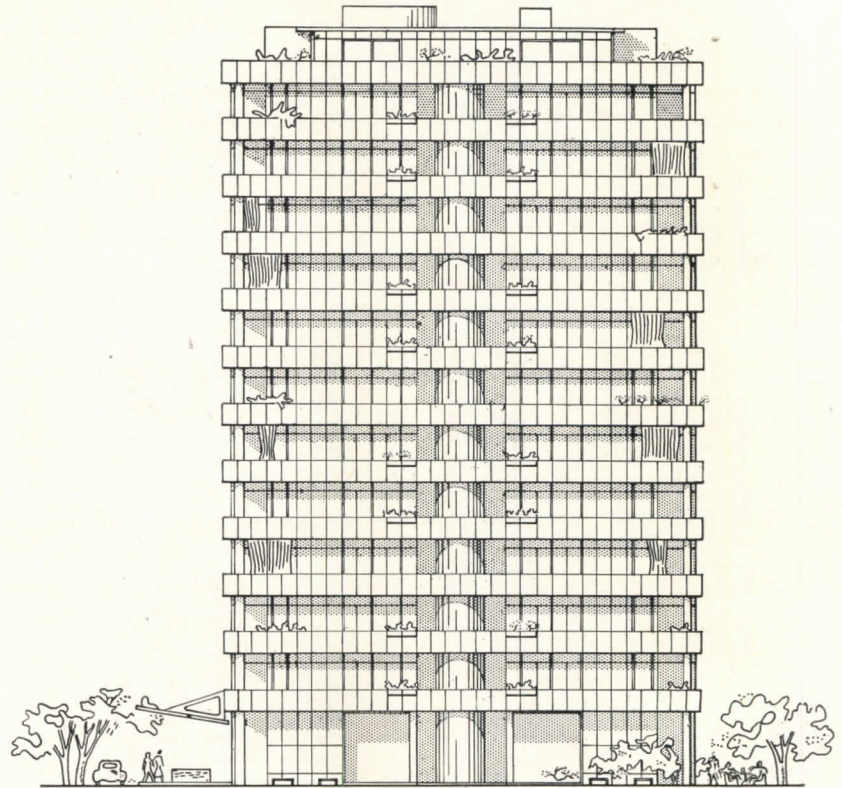
Many details of this system need modification and simplification to reduce the amount of hand labor required in its present form. The floor could be designed and built like our present "flat plate" construction or like the two-way concrete joist systems, such as the so-called "Grid System."

Wall sections possibly could be pre-cast in standardized sections, or special steel forms might be developed. The European method of using permanent forms which serve as a finished wall surface could also be well adapted to our needs.

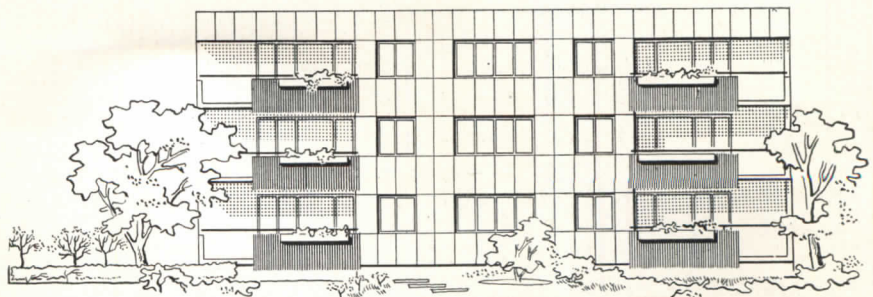
Simplified Design Method

Before general application can be attempted, a simplified method of design acceptable to building codes needs to be developed. This should not be too difficult, with present methods of experimental stress analysis. Recent commercial availability of the photo reflective stress analysis (*Presan*), developed especially for flat slab design, would seem to be adaptable to this type of work. As a matter of fact, it seems very likely that an adapted form of the *cellular* construction should bring about quite a few simplifications in both design and building in reinforced concrete.

ARCHITECTS' DESIGN FOR ELEVATOR-TYPE APARTMENTS

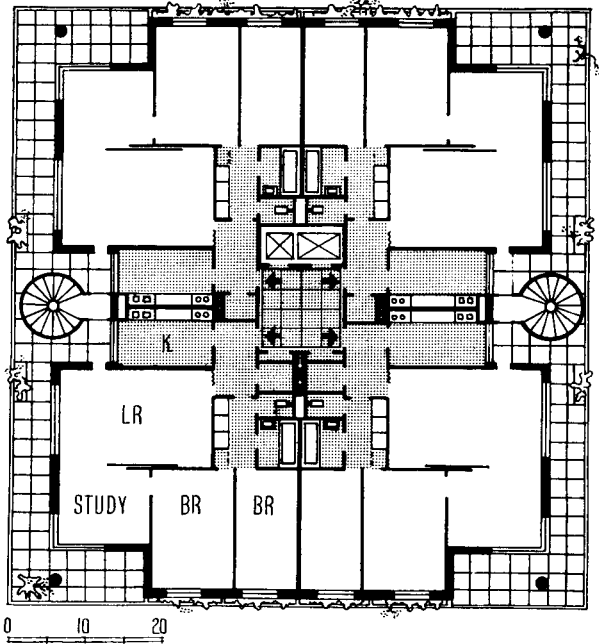


ARCHITECTS' DESIGN FOR WALK-UP-TYPE APARTMENTS

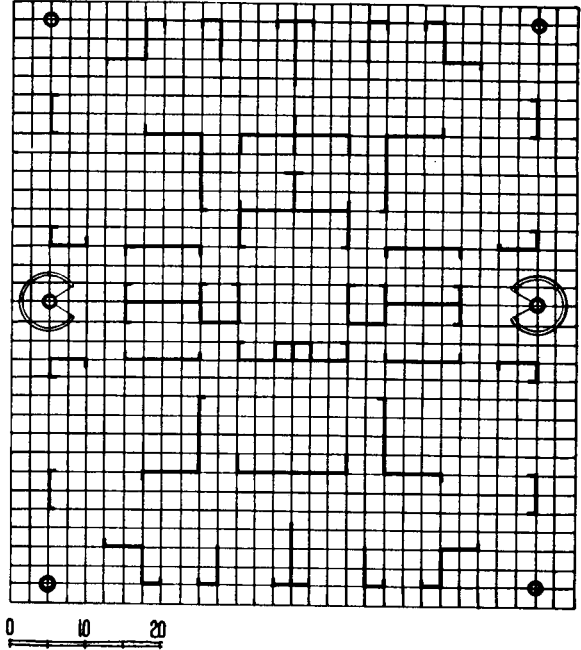


Elevator-type building designed with 12 floors. Four apartments on each floor are symmetrically arranged around the elevator lobby. The fire stairs are located outside the building itself, being accessible from terraces off the kitchens. There are four mechanical cores going through the building, ventilated by a central fan at the top

One module equals 2½ ft



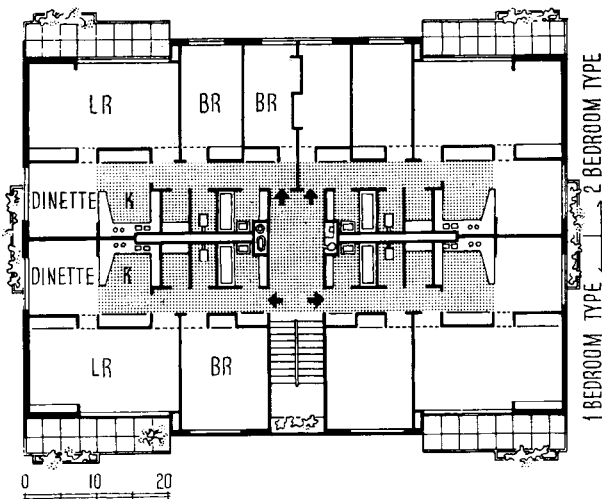
Typical Floor Plan



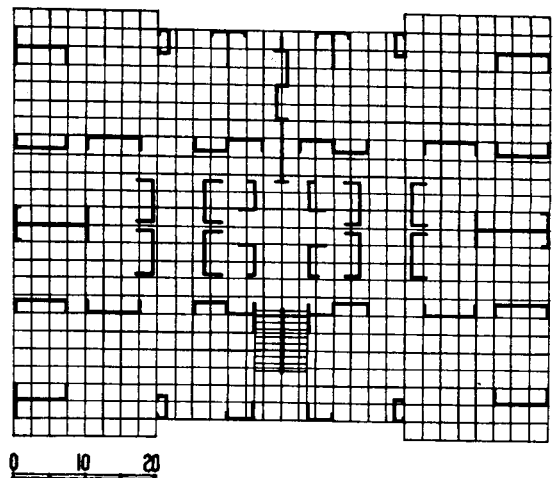
Plan of Load-bearing Partitions Only

Walk-up-type building with three floors. Each floor has two, 2-bedroom type, and two, 1-bedroom type apartments. Service areas are in the interior, and living areas around the edge; mechanical equipment is in two cores. Outside wall area is only 65 per cent of floor area

One module equals 2½ ft

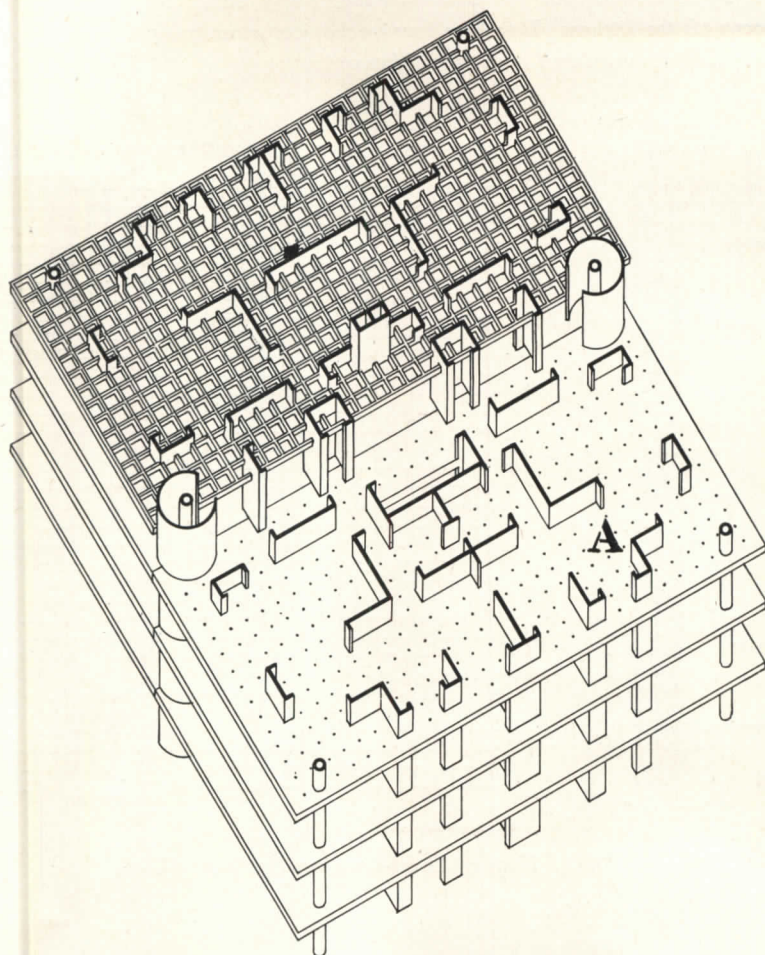


Typical Floor Plan



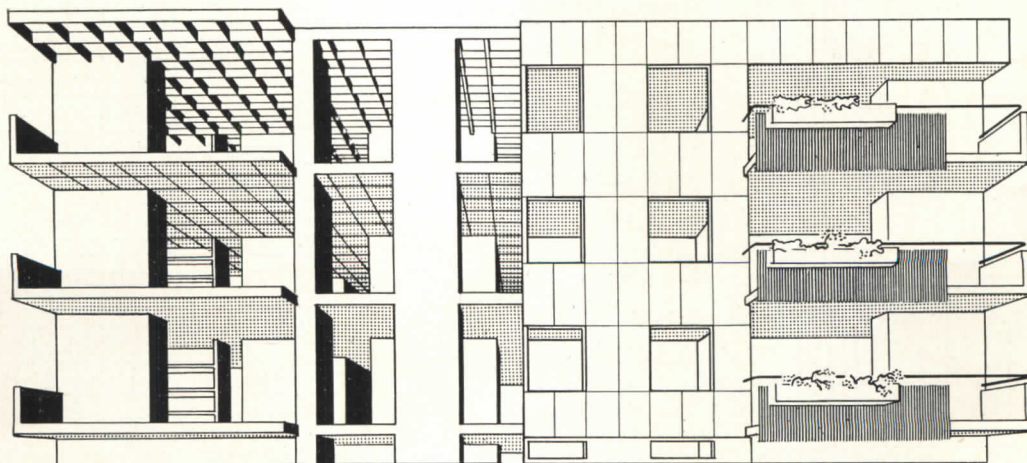
Plan of Load-bearing Partitions Only

ARCHITECTS' DESIGN FOR ELEVATOR-TYPE APARTMENTS



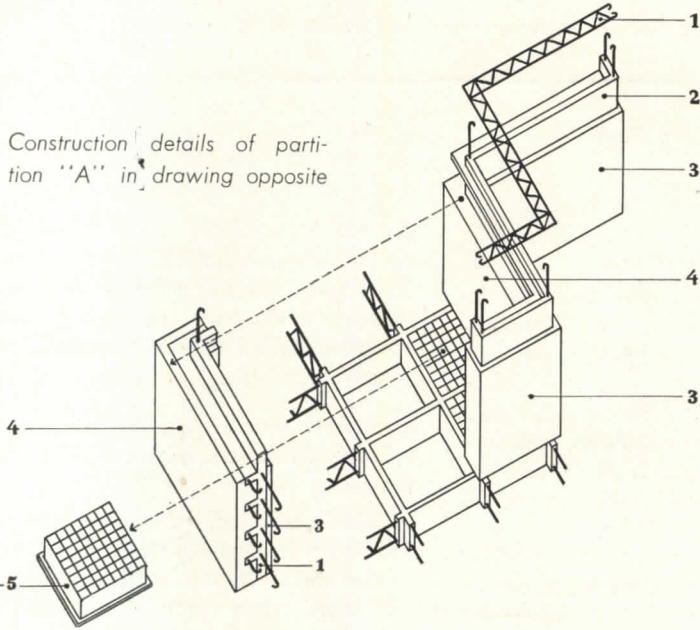
Upper floor in this structural sketch shows the two-way beam grid and how the load-bearing partitions lace through it. In the system as proposed for use in Europe, hollow core gypsum blocks fill in the spaces between the beams. These blocks may be left out to provide space for lighting fixtures. Ceilings are plastered and various types of flooring materials may be placed on top of the blocks. Partition "A" is shown enlarged at right

ARCHITECTS' DESIGN FOR WALK-UP-TYPE APARTMENTS



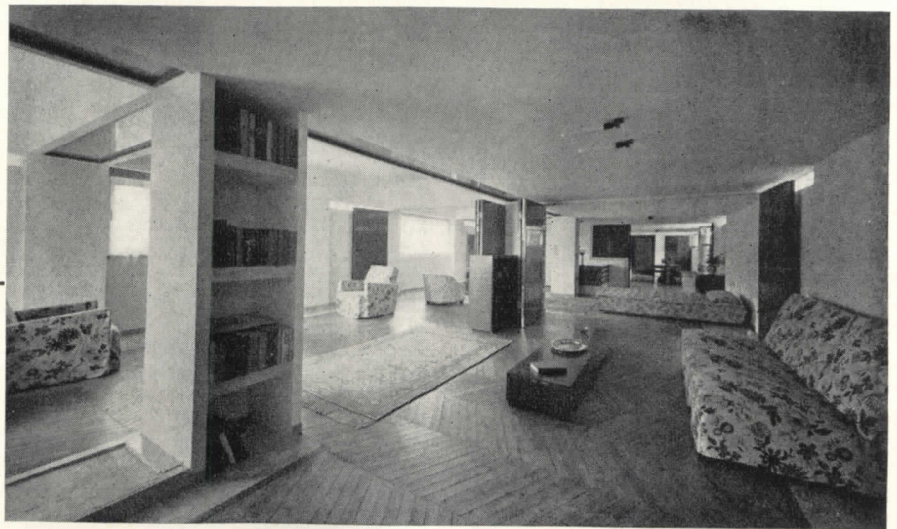
Perspective showing structural and facing elements of construction

Construction details of partition "A" in drawing opposite



LEGEND

- 1. reinforcing in the horizontal stiffening rib
- 2. concrete slab
- 3. precast exterior form serving as final finish
- 4. precast interior form serving as insulation
- 5. hollow core gypsum blocks



Top photo: apartment similar to ones illustrated on foregoing pages, but designed with fewer amenities for lower cost. Middle load-bearing walls are "U" shaped, with horizontal ribs being used as book shelves. Note glazed lighting strips which are easily formed in hollow spaces left in the ceiling. Bottom photo: here the load-bearing walls form cupboards. Spaces between them are filled with movable glass panes; glazed tile is underneath. Outside walls have one row of glass block at top

