INDUSTRIALISED BUILDING IN THE UNITED KINGDOM

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In describing the present situation of industrialised building in the United Kingdom, it is necessary to establish what is meant by industrialised building. Briefly, it may be described as a form of building in which as much as possible of the work is carried out in off-site factories under controlled conditions, so that work on site is reduced to a minimum, both in time and number of people employed.

In order to achieve this objective it is necessary for the design of a building to conform to certain modular dimensions, thereby allowing it to be constructed from standardised components with a given series of dimensional variations. The building itself must be of a repetitive nature which can be achieved with two quite separate forms of structure:

1. The open-space type of structure has long spans and open areas between supports. It is used primarily for schools, offices, industrial plants and hospitals.
2. The "egg-box" type of structure has the building divided into a number of relatively small cells. It has application for apartment blocks, hostels, hotels and the rest.

Both types can be made fully repetitive types of buildings.

OPEN SPACE STRUCTURE

Because of the particular stress on housing in the United Kingdom over the last four years there has been less development of the open-space type of structure. However, a light steel frame structure, known as Clasp, was developed some six or seven years ago and has been used extensively for schools. There are other systems following very much the same principle, in particular, Scola and Seac. In each case the system has been developed by a consortium of County Architects. The principal components are manufactured by private companies on the basis of large contracts which generally cover a year's production of schools by the consortium. It has produced very competitive pricing, details are standardised and there have been substantial savings in time in the architect's office. It is, I think, questionable as to whether or not this type of construction is showing any real economy over other methods. It has been difficult for those contractors who have spent much time and money on the development of the system only to lose out to a competitor who has "climbed on to the band wagon" after all the diffi-

The paper reviews the development of industrialised building in England and draws comparisons where applicable to systems building in the United States. Basic considerations for successful application of industrialised or systems building are given.

cult preliminary work had been done.

A number of precast concrete frames also have been marketed by private companies, notably Intergrid, which has been sold normally as a complete package for schools. The Bison Preferred Dimension Frame has been used for schools, offices and many other types of building, where comparatively large open spaces are required (Fig. 1). Other proprietary frames have come and gone, but in the last three years a standard form of construction has been devised by the Ministry of Public Building and Works, which is available for any manufacturer to

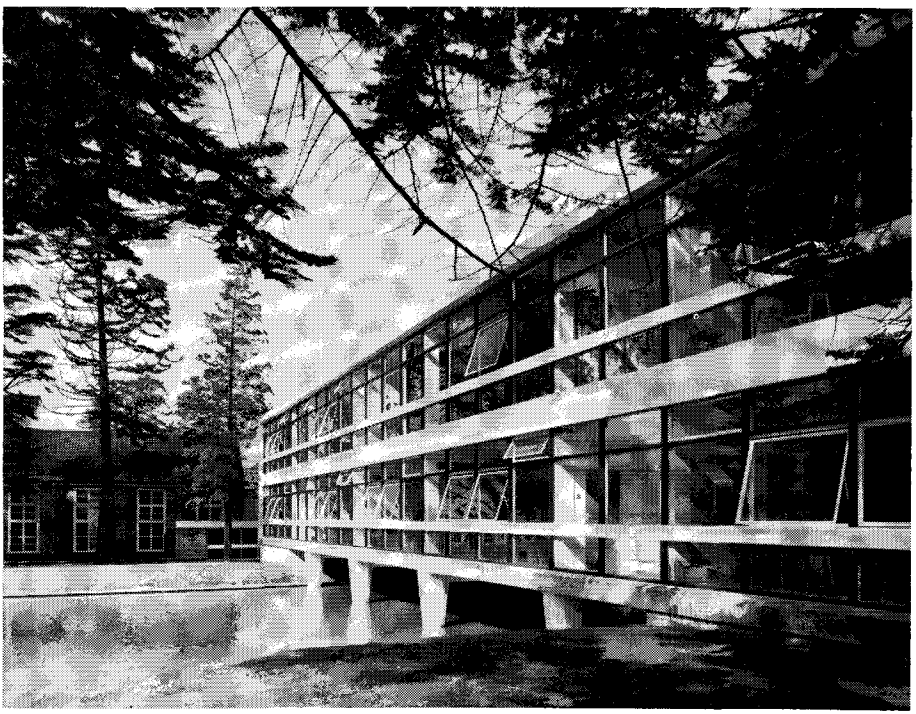

Fig. 1. A Bison Preferred Dimension concrete frame structure—Kidderminster High School for girls, Worcestershire, England

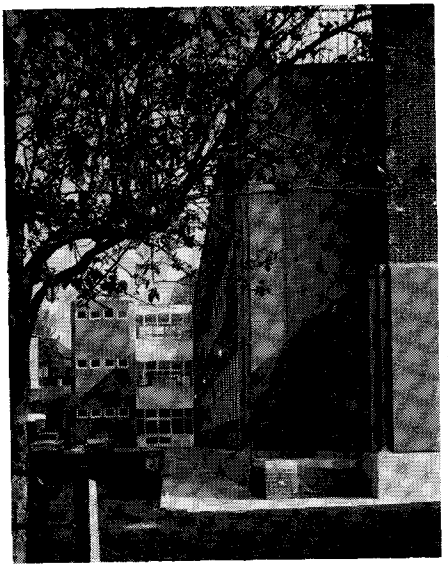

Fig. 2. A concrete frame structure with precast concrete cladding—Crown Office Building, Devonport, England

produce. A similar standard has been developed by an association of precast concrete manufacturers. From the developments, two points are clear, which I think are important:

1. While much time and trouble has been given to designing the frames on a modular basis, more development consideration must be given to engineering services and standardisation of internal sections of the buildings such as lavatories, cloakrooms and classrooms.
2. Whether the frame is of steel or concrete the cost of fixing the cladding is excessive when related to the cost of the frame as a whole.

ECONOMIC IMPORTANCE OF CLADDING

Many types of concrete cladding units have been tried, from the heavy architectural concrete panels, currently seen in the United States, to light, prestressed units 2 ft. wide and storey height. But no matter how inexpensive they may be to produce, by the time they have been fixed to the frame, the cost is almost as much as the intrinsically more elaborate cladding of the curtain wall type (Fig. 2). The opinion is now growing that the economic solution for enclosing these frames is for the cladding to be in the form of load bearing panels with windows cast in, which would replace exterior columns and edge beams. While there is nothing particularly difficult in the design of this form of structural element, a great deal of careful thought is necessary to meet corner and re-entrant conditions while still keeping the number of moulds within truly economic limits. Further, the moulds should be designed in such a way that adequate scope is allowed for the architect to exercise his proper skills on the elevational treatment.

FUTURE SCHOOL CONSTRUCTION

In general, as labour costs rise, the indications are that precast concrete will be used more and steel less. A good deal depends on the educationalists, and should they decide it is advantageous to use the much greater spans that are common in the United States, say up to 60 ft., this trend might be reversed. However, air conditioning is never likely to be considered for schools in Britain, so that the advantage of being able to pass ducts through lattice girders is one that does not arise. Whereas the school market is at the present somewhat reduced by economy measures, it seems more than likely that within two or three years it will become very active. One reason is that it is proposed to increase

the minimum school leaving age from 15 to 16 and a good deal of thought is going into ways of meeting this demand when it comes.

INDUSTRIALISED HOUSING

Industrialised building for housing started in Europe, but it was not until six years ago that the first industrialised apartment block was erected in Britain. This method of construction was introduced as the only possible means of increasing the output of housing when the building labour force appeared to be already fully committed. It received strong Government backing, and costs for the Government-subsidised work were allowed to rise above that for traditional building.

Since it was primarily low income group housing that was needed, all initial efforts in Britain were instigated and owned by city authorities with Government subsidy. It will be appreciated that this tended to produce a great many industrialised building systems; in a short space of time there were three or four hundred systems. Many of them never got off the ground at all and many more ceased operation after their first contracts. In the space of two or three years the number of effective remaining systems was probably between twenty and thirty.

This deserves particular mention as it seems that the present situation in America is likely to produce just such a spate of industrialised building systems. Your problem is, of course, on a vastly greater scale, but not when considered in relation to the sizes of the respective populations. I would suggest that you are now at a stage that we experienced when there was a great deal more talk about industrialised building than actual building. However, once the building got underway, we quickly sorted out the workable systems which were nearly all in precast concrete. The really important factor for success depended not at all on patents, but almost entirely on the practical experience of the producer in precast concrete and the amount of know-how he had managed to acquire on the related, but different approach of system building.

THE IMAGE OF TALL BLOCKS

The early projects were almost invariably multi-storey apartments ranging from eleven to more than twenty storeys in height. It was, and I regret to say to a large extent still is, this type of building which is almost always associated with industrialised building. It was soon discovered that these tall structures were the most economical application of the new technique and that for this type of structure industrialised building has great cost advantages over any other method (Fig. 3).

Fig. 3. Multi-storey Bison Wall Frame apartment blocks, Leicester, England

It is being undertaken on a vast scale in Europe, particularly in Eastern Europe where, although the blocks are certainly not very attractive, there are great numbers of them. In Czechoslovakia for example, out of a total of 85,000 dwellings built in a year, 60,000 are in these high blocks.

MEDIUM-RISE APARTMENTS

In England, however, it very soon became clear that there was a great demand for medium-rise and garden apartments. The Englishman's home is his castle and a great many Englishmen do not wish it to be in a tall block of apartments. The new methods were, therefore, adjusted to produce medium-rise dwellings. This was done with great success, especially in the elevational treatment which proved to be a far less rigid problem than with high blocks (Fig. 4). It is becoming clear that industrialised building techniques, as they are now being developed, provide a better quality of building which requires less maintenance and has a more interesting appearance than the traditional type, provided both are compared in the same price bracket. For a given structure industrialised building costs less and is quicker to build (Fig. 5).

CODES AND IDIOSYNCRASIES

Codes have been mentioned as a major constraint for industrialised building in America. I have had the opportunity of studying some of these, but I cannot really see that they present a very serious difficulty. In general, I would say that the requirements are different from those in England, but less onerous. For example, we are required to provide access from the bedrooms directly to the entrance of the apartment without passing through the living room. Lifts in Britain have inner and outer doors, but only outer doors are necessary on the continent of Europe. Manchester requires stretcher lifts not for the sick, who are carried in a form of deck chair, but for corpses which it seems must be kept flat. Most of the country accepted a floor to ceiling height of 7 ft. 6 in.

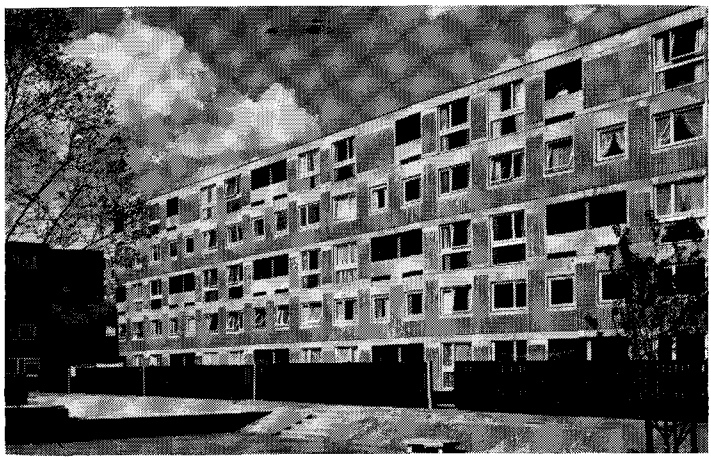

Fig. 4. A medium-rise housing development in Rotherham, England, using industrialised construction

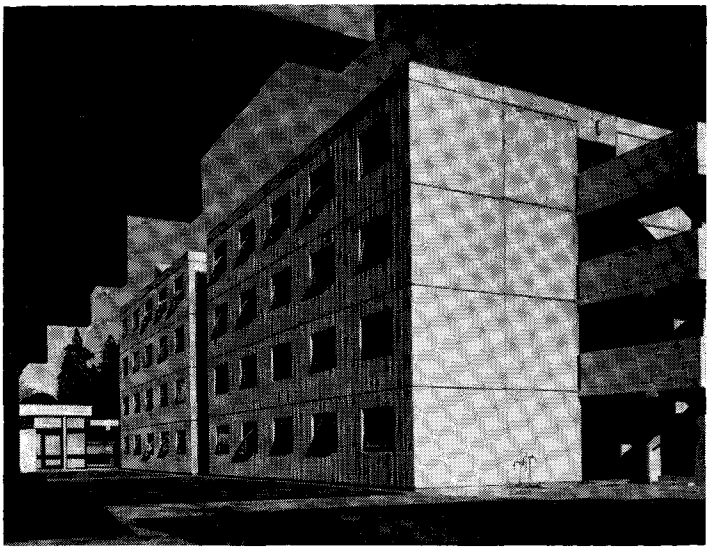

Fig. 5. Dormitory housing at new Training Centre, Cement & Concrete Association, Wexham Springs, Buckinghamshire, England

but, until recently when a compromise has been reached at 240 cm. (7 ft. 10½ in.), Manchester and London demanded 8 ft. All these and a great many more, particularly concerning water and electricity, we have managed to meet and I see no reason at all why, given a certain amount of time, the same sort of problems cannot be dealt with equally successfully in the United States.

Some problems relate to consumer acceptance. We have had great difficulty in persuading the customers to accept internal bathrooms and, even now, some steadfastly stand out against this innovation. We would like to introduce internal kitchens, but it is certain there will be formidable opposition to overcome.

FUTURE DEVELOPMENT OF INDUSTRIALISED BUILDING

What happens next in industrialised building? We feel that we have reached the end of the first stage. We have learned a great deal and have established certain standards, but we have come to the point where some basic re-thinking is required.

For example, we have learned that repairs and adjustments to precast concrete units on site are a luxury beyond our means. Handling of the units must be organised to avoid accidental damage. Greater precision in casting can be achieved which will involve important changes in our manufacturing techniques. Greater interchangeability of components is required within our systems so that a plant can be more flexible and can be switched to the manufacture, for example, of high-rise from medium-rise without any appreciable loss of production. The key to success is long experience in the design, manufacture and erection of structural precast concrete. The more you know about it the

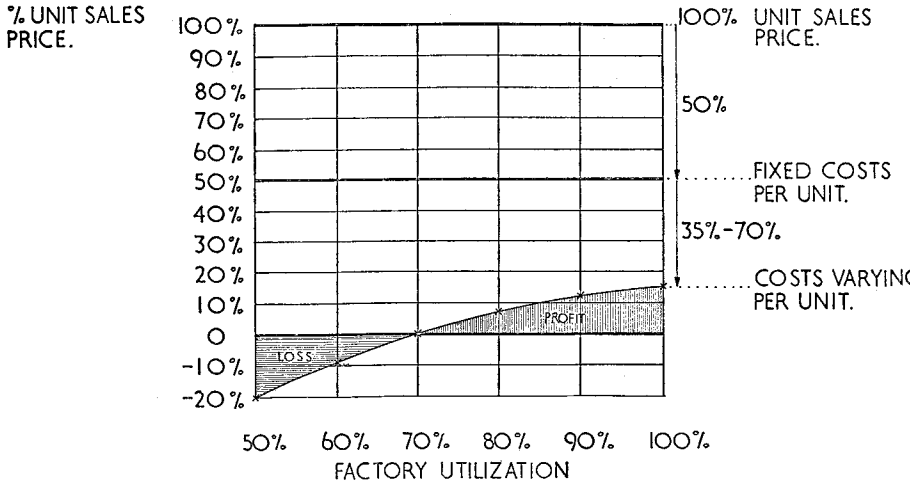

Fig. 6. Effect on profit of percentage of utilisation of plant capacity

more you realise how much more there still is to find out.

In the finishes, we think that insufficient advantage has been taken of the accuracy that can be achieved in concrete fabrication. When properly utilised, it should allow a greater degree of off-site prefabrication of joinery and partitioning. In Britain we are behind in this aspect of the work and the sort of approach that is needed is on the lines of the methods used by the U.S. mobile homes industry. A highly sophisticated production process would, I believe, produce a dramatic savings in time and site labour and improve the quality of finishes.

In Britain, the greatest market now is for two-storey houses. These single family dwellings in traditional construction are built most efficiently by small builders with an output of say 150 houses a year. The construction is entirely traditional, but they are well organised and have virtually no overhead costs. I believe industrialised building is on the way to becoming competitive even in this market.

Our most important endeavor at present is to overcome the popular image of industrialised building as a series of vast monotonous blocks typified by apartment building in Eastern Europe. We know now that we can build quickly and at low cost pleasant looking projects which people enjoy living in, and it is our firm intention to make them even better to live in. This, I am sure, will be one of the first aims of industrialised building contractors in the United States also.

THE BASIC RULES

To sum up, it now seems possible to enumerate certain basic considerations which are essential if industrialised building is to work.

1. The producer must have a long experience in structural precast concrete.
2. Design, manufacture and erection must be in the same organisation.

3. The system must consist of standard components manufactured with certain fixed dimensional alternatives which allow the components, when assembled, to provide a range of plans and layouts variable on a modular basis.
4. Detailed attention must be paid to the production of standardised components, with modular variations, for internal partitions, joinery, kitchens, bathrooms, etc.
5. The system must be kept under constant review for improvements in:
   a. Scope for elevational treatment, planning and layout.
   b. Production and erection techniques.
6. Except for the very large projects of five hundred units or more, the producer must resist all attempts by his clients to persuade him to work outside the stated limits of his system.
7. There must be a fully effective sales organisation capable of maintaining a steady flow of orders. Fig. 6 illustrates the effect on cost and profit of under-utilisation of plant. The cost of an idle plant is catastrophic.

If these rules are adhered to, automatically the industrialised building system is highly competitive in price, construction is very rapid, and the undertaking is profitable.

Discussion of this paper is invited. Please forward your discussion to PCI Headquarters by April 1 to permit publication in the June 1970 issue of the PCI JOURNAL.