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# The Systems Approach to Lower-Cost Housing

Kenneth G. Jessop

# THE SYSTEMS APPROACH TO LOWER-COST HOUSING

by

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## INTRODUCTION

Brinkmanship in the form of promised imminence of a revolution in the mechanisation of design and construction of housing has been with us for many years, and it seems that revolutions of one sort or another are always taking place. The very word "revolution" itself is the small change of modern publicity and, as verbal currency, its value has become grossly depreciated, with the result that many a revolution comes and goes leaving little trace. The "revolution" of System Building has certainly come and it has been with us long enough for each of us to decide, taking into account our individual experiences, whether or not it has progressed towards the respectability of a new and exciting alternative means of construction, or whether it remains in the shadows, as a mere substitute, to be discarded when more attractive methods become available.

In the United Kingdom, the Government sponsored National Building Agency acts as judge, jury and custodian of authorised building systems and their secrets, giving their stamp of approval only to those that meet the stringent N.B.A. standards. A recent N.B.A. publication referring to system built dwellings showed that the productivity on such sites was 70% above the level experienced with traditional methods of construction, and furthermore, required only 50% of the site labour considered necessary hitherto. These statistics prove beyond all doubt that savings both "direct" and "indirect" can be achieved with the probability of further improvement with continuing experience, but perhaps the greatest saving of all results from earlier contract completion dates. However, at the present time, when building costs in Britain are escalating at the rate of 1% per month, any form of planned building, call it what you will, that will save on site labour and construction time must show considerable and progressive advantages over olden methods conceived and designed for another age.

System Building, which began life with the dubious title of Prefabrication, progressed through a variety of pseudonyms such as New-traditional, Non-traditional and Industrialised Building to its present clear and concise description.

Time prevents me from giving a blow by blow account of the fight to establish System Building in the United Kingdom but one point is abundantly clear, the initial opposition to the technique was such that the pretty propaganda wrapping that usually accompanies a new venture was quickly torn aside, leaving the bare package. Nothing was taken at face value and all of the early systems were exposed to hostile scrutiny to stand or fall on their individual merits, and thus we establish the high degree of selectivity which so influenced the future of System Building. In fact, the rush to the barricades by the traditionalists had the very opposite effect to that intended, since every tactical debate staged by the opponents of System Building provided a platform for those durable supporters of factory made homes to pursue their worthy cause. For some odd reason, Authorities demanded higher standards in most aspects of the systems approach than they had happily accepted for traditional methods hitherto, and indeed currently, and predictably, this additional "inconvenience" produced "luxury" when "adequacy" would have been sufficient.

## TEMPORARY HOUSING

The problems facing housing authorities at the end of the second world war were formidable. There was the inevitable backlog of slum clearance and development, the normal annual increase of housing needs coupled with the requirements of the returning thousands from the armed forces, and, finally, the additional problem of replacing homes destroyed by action of war and this brought into stark reality the task of providing large numbers of dwellings in the very hearts of our great cities. The Government quickly organised into suitable associations many of the companies so recently fully dedicated to the production of war products and the integration of effort and co-ordination of supply, storage and distribution were quickly put into effect by the then Ministry of Works under the overall umbrella of "The Temporary Housing Programme".

A series of single-storey houses, designed for a life of 60 years but planned for 10 years, was developed employing a wide variety of materials and each housing type became a "Project". The control of each "Project" was entrusted to a General Managing Contractor who set up storage centres (usually disused airfields) to receive the various components contracted for by the Ministry. Thus the units were received, efficiently stored and distributed to construction sites in house sets. The dwellings of 2 and 3 bedroom types included central heating, fitted bathroom, inside toilet, kitchen with refrigerator - in fact a much higher specification than the majority of the new tenants had enjoyed prior to their occupation. The single-storey housing units were erected on odd areas of land, including many bombed sites, and in time the horticultural efforts of tenants created attractive little oases in most unlikely surroundings. The various methods of external construction adopted included storey height concrete panels, steel frame and asbestos sheeting, fibroboard on concrete frames, and timber. Invariably, the houses were lined with plasterboard faced timber frames insulated with fibreglass wool. A late starter in the Temporary Housing Programme was the aluminium house produced by aircraft firms quickly adapting their production capacities from aircraft to housing. The Temporary Housing Programme begun in 1945 was virtually completed by the end of 1947.

## PERMANENT SYSTEM BUILT HOUSES

### First Phase

Concurrently with the Temporary Housing Programme, rapid advances were being achieved with the adoption of production techniques to permanent dwellings and already the move towards pre-engineered homes was under way - in fact, some Companies had some two years' experience to their credit. Initially, the house types were confined to one and two storeys, but low and medium rise apartment blocks were quickly developed. Some of the earlier systems failed to survive the demands of technological and environmental change and it is important to note, that with very few exceptions, it was those systems employing concrete as its main structural medium that progressed to a regular place in the history of System Building. However, since the inception, there has been continuing research and development into design of joints, horizontal and vertical connections, sound and thermal insulation and many other important technical aspects of living. During this first phase, all concerned were perhaps more engrossed with quantity rather than quality and, in consequence, the early designs suffered from lack of individuality. It was therefore inevitable that immediately following the completion of the first contracts, thoughts turned to improvements in individual and collective house designs.

The lessons learned from this first excursion into System Building were many and varied and the fact that it failed to achieve its full potential resulted not so much from technical reasons but from shortsighted and conflicting attitudes adopted by many of the participating authorities. It is sad but true that on occasion the heavy hand of "persuasion" was observed, whereby applications by some Housing Departments for houses succeeded only on the understanding that a large proportion were built by industrialised methods - thus before a single dwelling had been constructed, resistance and prejudice were established. It was extremely fortunate for the future of housing and for those needing accommodation that a few of the more tenacious system builders persisted

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to the point where pre-engineered homes were erected in sufficient numbers and in different environments to an extent whereby occupiers from a wide section of the community were able to judge for themselves the justification of a place for method building in house construction.

Second Phase

The second major drive by British system builders was launched in the 1950's reinforced by the best of continental systems. The new approach was based on much more realistic principles offering a wider choice in terms of aesthetics and structure. This second phase carried system building techniques into medium and high-rise structures in large numbers and faced fair and square up to the problems of environment. Clearly, the lessons had been learned - Housing Authorities were no longer compelled to purchase the types of dwellings the sponsors felt they should have and they became more selective and discerning with their firmer requirements, with the result that the Housing Authorities, who were best able to identify their particular needs, clearly specified their requirements and, within reasonable limits, the systems complied. Immediately the chances of acceptability and success were drastically improved and many Authority/Contractor relationships previously doomed to the limitations of conflicting interests moved towards genuine partnerships with mutual objectives. This change of heart was the major contributor to the real success of System Building which from that point gathered momentum with the move towards the development of high-rise structures of up to 20 storeys. The rapidly changing skyline of Europe now provided ample concrete evidence of a successful venture into mechanisation of method.

Third Phase

The 1960's brought further sophistication with system built apartment blocks pushing up towards 30 storeys and with them commenced the trickle of human and social problems that was subsequently to become a flood before being resolved by monumental effort on the part of all concerned. I do not aim to be over-critical, since System Building has without question eased hundreds of thousands, indeed millions, of personal problems and even though those remaining are few, they must not be ignored. Some are fairly predictable, others we discover as we go along; but these are not problems associated solely with System Building. They have been with us ever since the inception of organised house building. Their discovery and identification was a beneficial by-product of integrated planning synonymous with System Building.

The growing involvement with environment quickly showed up in the type of contracts let to system sponsors - whereas earlier, they merely bid to supply houses, their submissions now included complete layouts and each bid was judged accordingly, so that whilst price remained a major criterion, other factors could and did sway contract selection if they fell short of the standard demanded. It was at this stage that moves towards layouts with pedestrian segregation were introduced with varying degrees of success. At the same time came improvements in housing standards themselves which laid down minimum terms of acceptance covering room sizes, insulation factors, equipment, fixtures and fittings, and so on, and at the same time price yardsticks were established. This created a highly controlled situation, which although intended to protect the occupants sometimes precluded deserving cases on the grounds of cost. In fact, the plea was sometimes heard "I cannot afford an apartment with such high standards - is there not a cheaper and lesser equipped place for me?". Sadly, there was not, for the minimum remained high. I do not say that this is a bad thing - I merely offer a note of caution in adopting too rigid an attitude with respect to the requirements of potential occupants without investigating the desires of the people in the light of their individual resources and preferences.

The enormous technical advances of industrialised methods are self-evident but the vitally important successes achieved in resolving human and social problems are less so. Following the construction of medium and high-rise apartments involving elevators, gallery access, tower blocks, scissor blocks, internal corridors, there have been ample opportunities to give sympathetic understanding to the views of the occupiers and recognize the need for human dignity along with the more basic requirements of living. People are not cattle, the man removed from the slum area with a back-yard, often never used - does he now yearn for his garden?

The high-rise dweller - does he happily accept clearer air and the minimised noise level, or does he fall victim to altophobia? Do apartment dwellers with elevator access become isolated from all other than their immediate neighbours? Do gallery access apartments provide opportunities for prowlers and vandals, or do they provide the same common meeting ground that city streets enjoyed in other days? Whilst much is being done, there are many questions yet to be asked and answered before we are anywhere near the point where we can claim a comprehensive knowledge of the human problems to be faced in housing our people. In a word, housing, system or traditional, must have a conscience. It has been said that what is wanted is not more "Industrialised Systems" but more "Industrialised Clients".

AMERICAN NEEDS

With the rapidly growing need for housing in South America and the wide acceptance of System Building principles in North America, the period of brinkmanship is over; the problem is identified and the solutions proposed are many and varied. The continent of America embraces every conceivable climatic condition, the widest range of geographical considerations, a complicated permutation of skills, materials, preferences and statutory influences, together with many other contributing factors, and it would be impertinent to offer a single solution to such a complex problem.

One may follow the European practice by dealing with a given set of requirements in a particular way, and, without doubt, through the effort of many participants, this is how System Building will be dealt with during the formative period. However, is it not logical to assume, that nobody can possibly identify the needs of America like an American? and, through association, given the backing of know-how, knowledge and experience in specific techniques and processes, and the means, developed in the field over many years, coupled with American skills and direction, he will resolve the majority of American problems.

The fact has already emerged that the plant requirements of American producers differ considerably from their British counter parts, as indeed they in turn differed from their opposite numbers in Europe proper, and it is reasonable to presume that once the early housing programmes become reality, then very specific requirements will be called for in terms of plant and erection techniques.

It is interesting to note the numerous approaches to the housing problem being undertaken in different parts of the U.S.A. these involve a multitude of systems employing most usual, and some unusual! structural media, but even within the limitations of the material widely used, namely, concrete, methods vary considerably and include simple block construction, frame and infill panel, large heavy panels, and progress to 3-dimensional casting such as complete box units, part box units and in situ concrete porticos. Thus, with the traditional courage and pioneering spirit, for which American architects, engineers and constructors are famed, one can confidently expect in time to view spectacular and adventurous structures in the field of System Building.

Three advanced techniques are making spectacular headway and seem to be closely associated with Anglo-American endeavour. They have but two common denominators, namely, "Concrete" and "Success", yet in all other aspects they differ considerably.

The first is the Rouse-Wates approach involving site factories producing large precast panels by horizontal and vertical mechanised casting methods. This system had previously made an important contribution to the housing needs of London and other British cities.

Sectra is the second system, operated by Noonan-Laing, and involves an in situ casting system employing tunnel form porticos manufactured to very close dimensional tolerances with high grade surface finish. This system has enjoyed success, not only in the

United Kingdom, but in France, its country of origin.

The third method is more homespun in that the three-dimensional casting system was developed by Mr. S.W. Shelley in conjunction with my own Company to provide completed precast concrete boxes fully equipped, and apartment blocks using this system were first constructed at San Juan in Puerto Rico. The system is currently under construction within the United States proper.

In addition to these three major excursions into the American housing field, I have been privileged to work in close association with several other American pioneering organisations and I hope to illustrate some examples of the results of that collaboration.

## THE SYSTEMS APPROACH

While System Building was born of a famine in skills, both professional and craft, and influenced by a shortage of traditional materials, perhaps the greatest benefit lies in the essential planning, without which, system building would not have achieved the international success that it has. It is clear that economic availability of the necessary materials, high rate production and high density construction, all demand rigid discipline and efficient planning with uncluttered lines of communication if one is to avoid a tangled web of haphazard operations, and if system building has done nothing else, it has made all involved with it efficient planners, but it is fortunate for the home hungry millions of the world that the achievements recorded range far beyond this particular advantage.

To summarise this single but supremely important point -"if you haven't got planning, you haven't got a system". One may survive one or even two contracts, but continuity of system building is completely and utterly tied to a planned existence.

I hope I have made the point that System Building is no different from every other aspect of the modern day world in that as each day passes so the complexity of living increases, but underlying the initial reasons for planning a subtle change takes place. Originally, planning was vitally essential in order to co-ordinate the many and varied operations and processes that would take place, sometimes in a variety of locations all directed towards the completed dwelling, very much on the lines of a critical path network. Sometimes, changes were necessitated by the reducing availability of specific materials, techniques or skills but in recent years a very special problem has made heavy demands upon the knowledge and ingenuity of system housing equipment designers, namely, rapidly growing emphasis on labour costs. There is very much in system building, as in any other industry, that is desirable and undesirable, essential and non-essential, but when one takes into account the inescapable fact that labour costs have doubled over the past 10 years, it can be readily appreciated that here lies the biggest problem of all. As a direct consequence of spiralling labour costs, one could no longer deal in isolation with individual aspects of system building. The plea that I have so often made at other times in other places to forget first costs and concentrate on final costs is no longer valid for any given single aspect of system building - one must now apply this principle to the overall operation, embracing design, planning, manufacture, handling, erection and finishing trades, sometimes sacrificing desirables in one division to the benefit of essentials in other. Taking into consideration the total package of system building, there still remain many opportunities to reduce final cost, sometimes even at the expense of increasing expenditure on some individual items. It is not inevitable that savings have to be paid for - for example, all other things being equal, a six-cell battery mould requires just the right phasing of preparation, casting and re-preparation for a small team of operatives to complete in a single shift. A larger battery having a greater number of cells would demand more operatives with the probability of an extended working day with an increased labour cost/square ft. factor. With this type of problem in mind, the fact emerges that the role of the equipment supplier must not be contained to the design and manufacture of equipment.

The full impact of his experience, both within his specialised industry and in the general field of concrete production, must be brought to bear at the time of early planning. He must be involved in, and advise upon, methods of production, handling, plant layout, taking into account the availability and cost of skills and crafts at all levels, the rate and types of concrete components required, the erection programme, unit handling and concrete feeding methods - indeed, everything contributing to the finished structure. Only then can he claim to be aware of a client's problems and design equipment accordingly for that particular job. It should be a normal expectation of a client to receive with his concrete production equipment full charging diagrams, information on labour allocation, and a host of other technical advice and information. In fact, the equipment supplier does not provide a service to the system housing industry - he is part of that industry, whether he likes it or not. Above all, it should be recognised that efficient working during the commissioning period should not lead to the assumption that this happy state of affairs will automatically continue on a grace and favour basis - therefore, the formwork supplier must play his part in establishing installation, commissioning, maintenance and remedial services. It is no secret that in some under-developed countries it is the equipment supplier who carries the flag of System Building, offering a complete turnkey deal, including architectural and engineering services, complete plant installation and recruitment and training of skilled personnel, and it is from the knowledge and experience gained from such ventures that the advances in System Building techniques are initiated. It is often said that in an advancing industry one should not dwell in the past, but at least one should learn from it when forging the future.

Much is made of the term "System Building" but in this modern age when the benefits of planning are available to all, there is perhaps no longer anything really new about the techniques, only in the applications. The wide use of dimensionally co-ordinated factory made components erected by highly trained personnel to carefully phased construction sequences is fast approaching the rule rather than the exception in many parts of the world. System Building is no more and no less vulnerable to the charge of monotony and uniformity than structures employing traditional materials. Industrialised building responds equally to sympathetic treatment by architects and engineers and there are many, many examples all over the world in evidence of this fact, just as there are many "architectural horrors" in all types of structural media.

In conclusion, System Building does not represent the death of architecture any more than it may mean the end of gracious living, but it does need the sincerity and sympathy of individual architectural treatment no less than the simple brick.

Can the architect accept the challenge and, what is more to the point, will he?


## ACKNOWLEDGMENTS

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Omniform Systems Inc.
Portcrete Ltd.
Reema Construction Ltd.
Rocky Mountain Prestress Inc.
Rouse-Wates Inc.
Scottish Construction Ltd.
Shelley Systems Inc.
Stelmo Limited
Taylor Woodrow Anglian
Taylor Woodrow Construction
Wates Ltd.

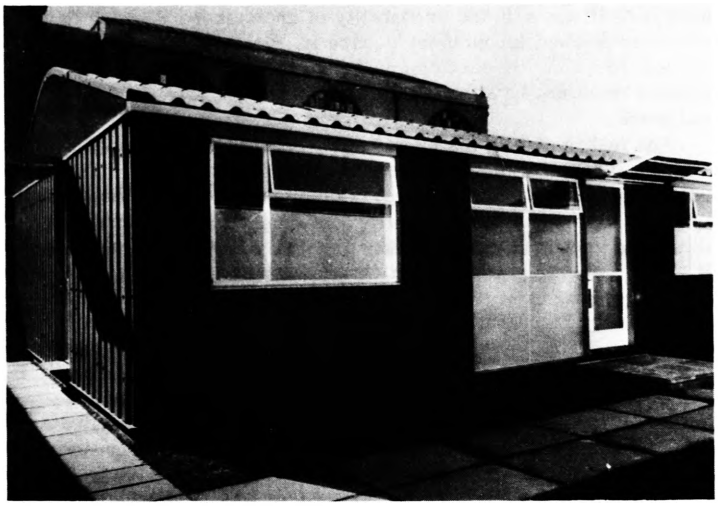

Fig. 1. Prefabricated Temporary Bungalow

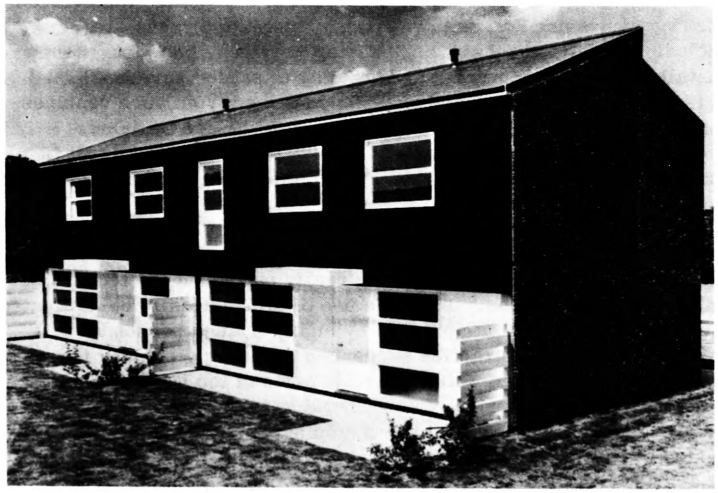

Fig. 2. Rationalised Traditional Houses.

Fig. 3. High-Rise Apartment Blocks, London, England.

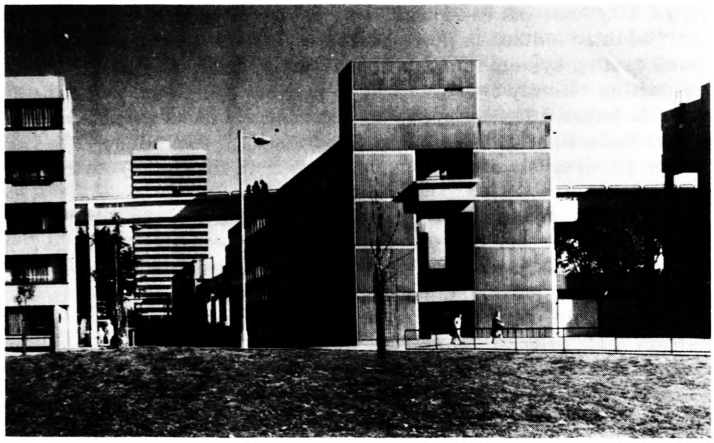

Fig. 4. Medium-Rise Apartments with Gallery Access.

Fig. 5. Shelley Box System, Puerto Rico.

Fig. 6. High-Rise Apartments adjacent to Factory in Maassluis, Holland.

Fig. 7. Permanent Factory for Balency System, Thamesmead, England.

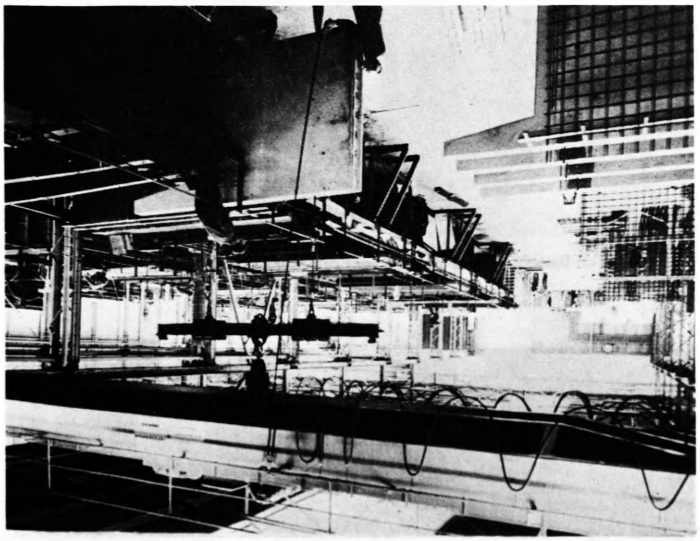

Fig. 8. Permanent Factory for Larsen & Nielsen System, Maassluis, Holland.

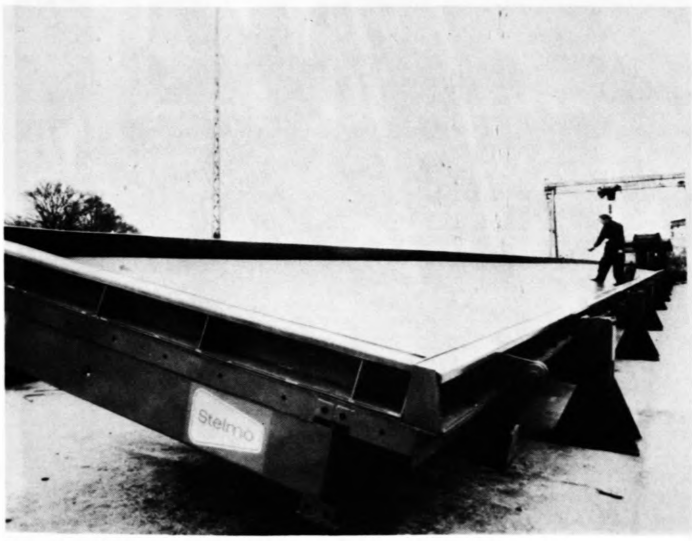


Fig. 9. 150' Co-ordinated Tilt Table for Omniform System, New York.

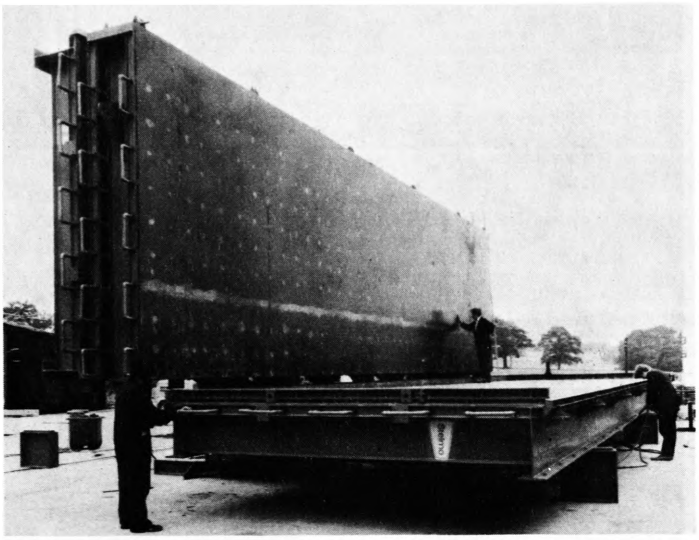

Fig. 10. 2-Cell Tilting Battery Casting Machine for Rocky Mountain Prestress Inc., Englewood, Colorado.

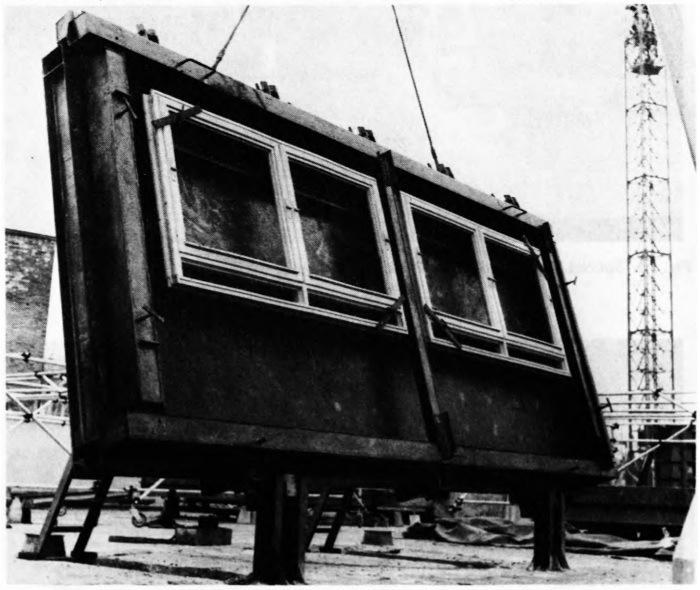

Fig. 11. Window Panel Tilting Mold for Wates System, England.

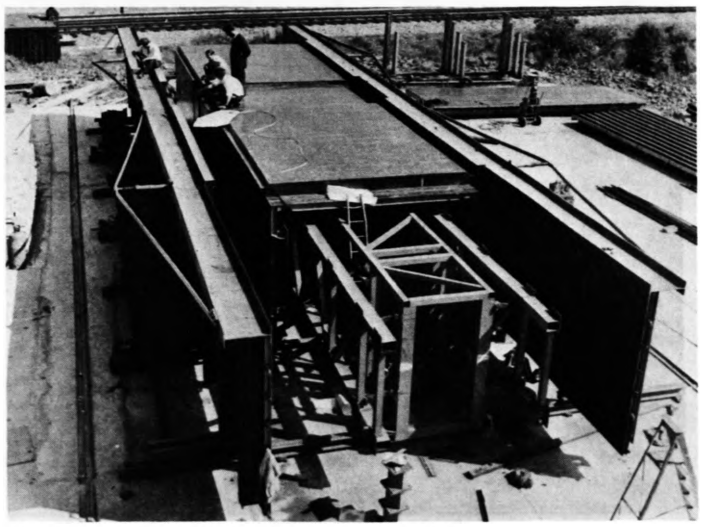

Fig. 12. Universal Box Mold for Shelley System, New York.

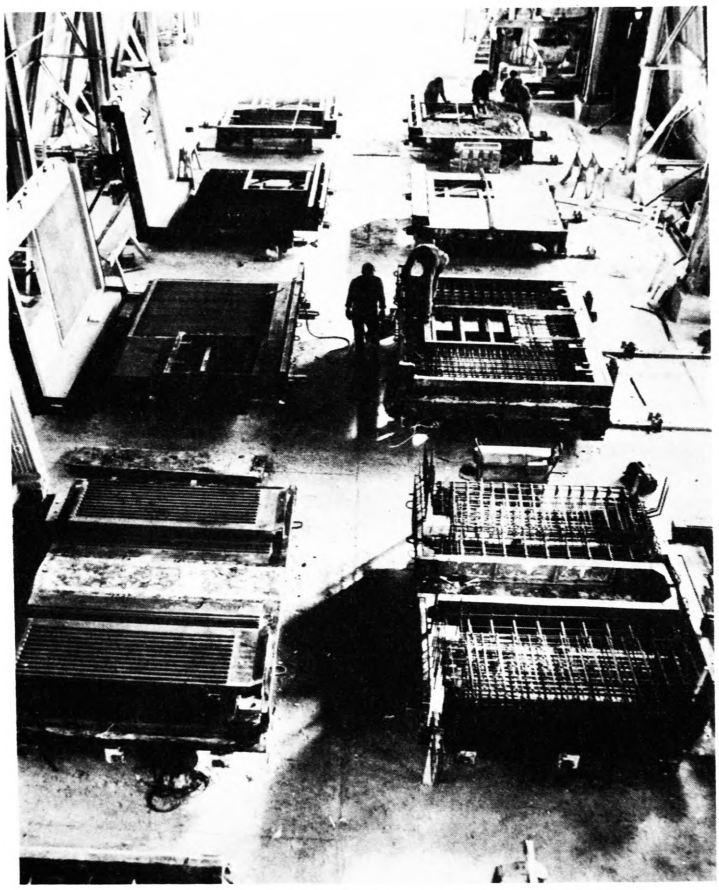

Fig. 13. Special Facade Molds for Portcrete, England.

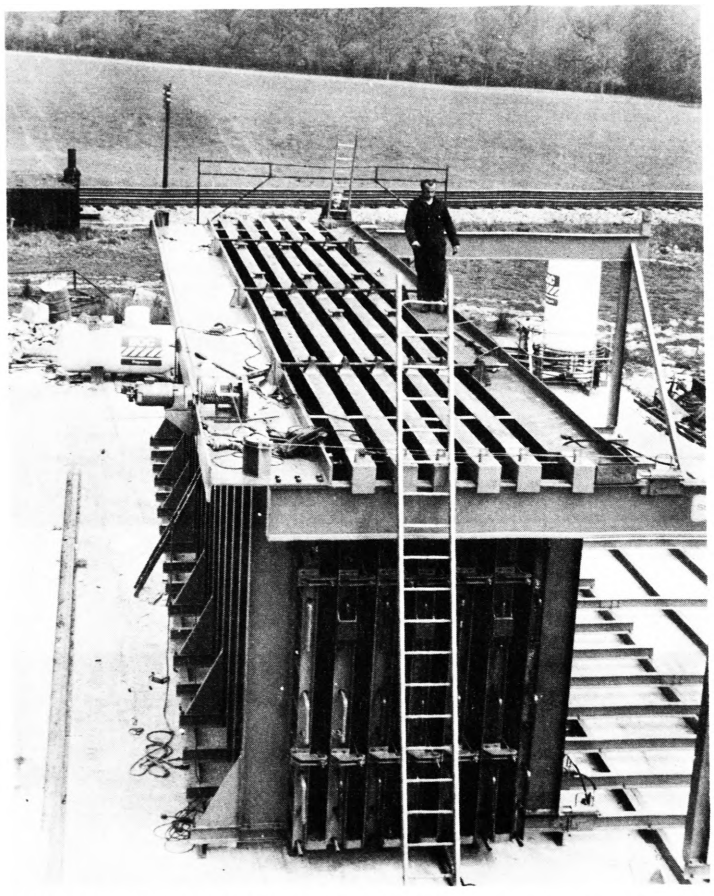

Fig. 15. 6-Cell Battery Casting Machine for Echo Module Systems, Inc., Massachusetts.

Fig. 14. Tilting Window Panel Mold, Hendon Police College, England.

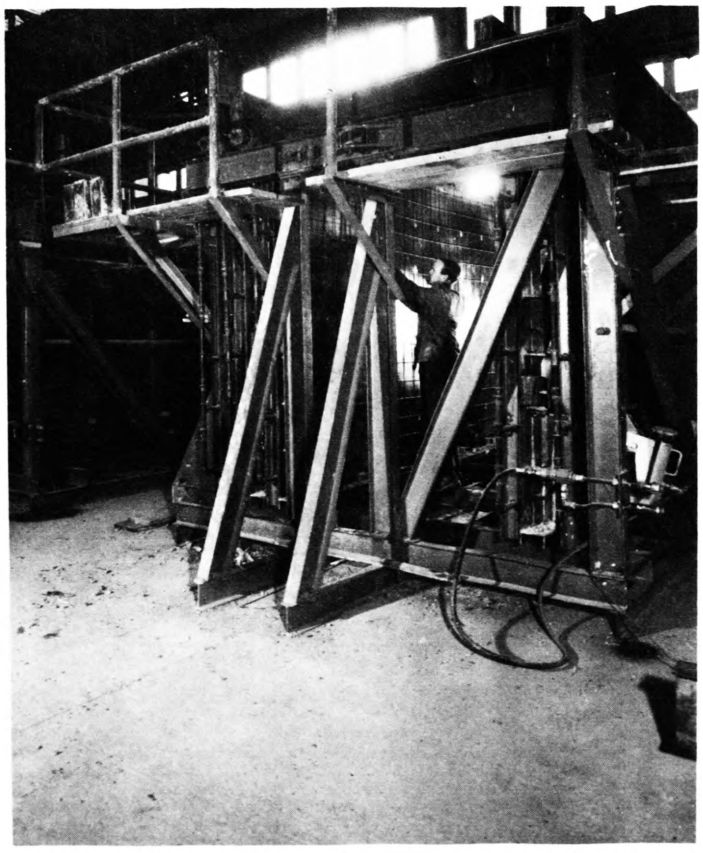

Fig. 16. Vertical Battery Mold Preparation for Scottish Construction, Scotland.

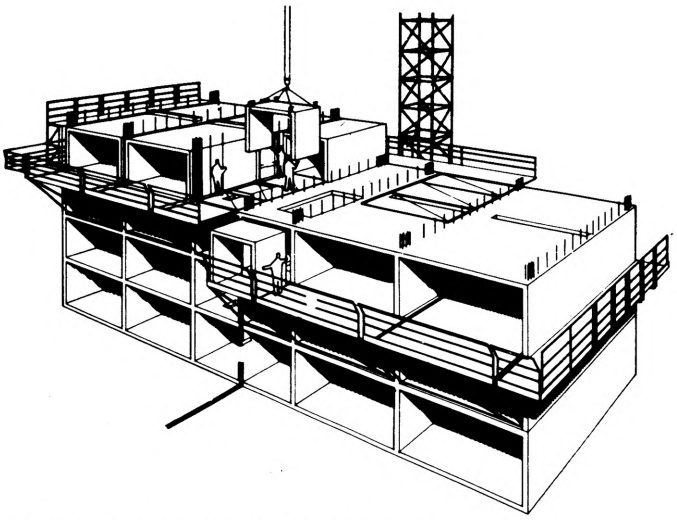

Fig. 17. Principle of 'Sectra' cast in situ Portico System.

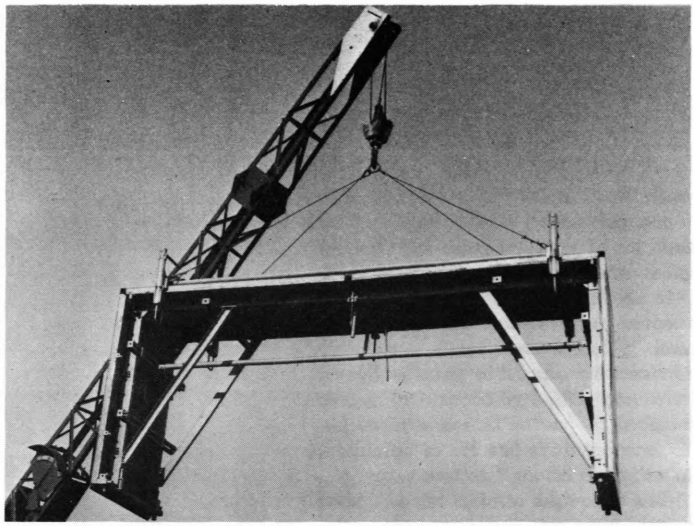

Fig. 18. 'Sectra' Portico Unit in service.