

## Development of large-panel construction in European countries

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The large-panel construction which, in the USSR, was begun in 1948 is today considered to be the most effective approach to the industrialisation of housing. Its volume and rate are growing steadily in all European countries. In the USSR where in 1956 16 thousand dwellings were built in large-panel blocks of flats, in 1961 this number rose to 120 thousand and in 1963—to 280 thousand dwellings, not taking into account completely prefabricated houses with large block walls. In France 90 thousand flats a year are now being built in completely prefabricated buildings, with large block and panel walls. In Czechoslovakia 35 000 flats were built in large-panel buildings in 1961.

Large-panel housing is successfully carried out in Sweden, Denmark, Bulgaria, Rumania, Hungary, German Democratic Republic, German Federal Republic and other countries of Europe. It begins to develop in Great Britain where up, till recently, preference was given to traditional structures of brick and in-situ concrete. Experience shows, the cost of large-panel construction is 10–12 per cent lower than that of traditional brick construction, and building time-tables are 1.5–2 times shorter. In different countries labour-expenditure on large-panel construction including the outlay of labour in manufacturing details at factories is 5–7 man-hours per cubic metre, 35–55% of which, depending on the degree of prefabrication, fall on the factory. These labour outlays are considerably lower than those in traditional building.

Technical potentialities of large-panel construction are very great. In France, Sweden and other European countries, many large-panel blocks of flats up to 16 and even 22 storeys high have been built.

Large-panel buildings are notable for considerable variety in lay-outs of dwellings and are not inferior to traditional brick buildings in architectural aspects corresponding to a greater degree to the modern ideas of architecture.

Schools, children's institutions and buildings for cultural and every-day services are also being built of large panels.

### Structures of large-panel buildings

International collaboration and wide exchange of information promote the unity in approach to a number of aspects in the developments of large-panel construction. A frameless system with load-bearing cross and longitudinal walls and solid room-size floor panels supported round the perimeter is wide spread in most countries. The most part of large-panel buildings in the Soviet Union, France, Czechoslovakia, Sweden and other countries are built according to this scheme. The main advantages of this system which determine its wide application lie in its structural reliability, economy, simplicity and high degree of prefabrication. In the USSR, Czechoslovakia and some other countries structural systems with three load-bearing longitudinal walls or with load-bearing cross walls spaced at 6–6.40 m with floors of cavity panels 1.20–3 m wide are also used. Partition walls are made of large-size rolled gypsum-concrete panels or of other similar materials. Such structural systems make it possible to provide more variable lay-outs of dwellings and to partially utilize in large-panel construction the production basis created earlier for brick construction. However the use of floor slabs with joints in the ceiling and erection of partition walls of different materials require additional finishing of the buildings on the site. The frame-panel system is used mainly in construction of administrative and commercial buildings. At present in the USSR, in Moscow, it is planned to use it for the construction of residential buildings 16–25 storeys high.

Exterior wall panels are used, both of a sandwich type with expanded polystyrene thermal insulation, mineral, or glass-wool boards, and of a solid type made of light-weight concretes or of cellular concrete. Solid panels are more convenient for manufacturing but in their thermo-technical characteristics they are inferior to sandwich panels and in many cases they require additional protection.

Room-size panels are predominantly used for the erection of exterior walls. However there is a trend to enlarge them to 2-room-size and even 3-room-size. The fabrication of room-size exterior wall panels of cellular concrete with thermal treatment in autoclaves of 3.6 m in diameter has been organised in the USSR.

Exterior wall panels leave the factory complete with window frames already pointed and glassed, with face surfaces fully finished with ceramic tiles, crushed stone or coloured textured layers. Load-bearing panels for interior walls are usually room-sized, solid, 130–150 mm thick.

The joints of panels are the most vulnerable spots in large-panel structures. The questions of the most efficient jointing and the methods of insulation of joints were discussed at the meetings of CIB Commission W19 in Paris in 1961, and in Stockholm, in 1963.

The exchange of information and experience made it possible to work out, and put into practice, horizontal profiled joints with storm-water barriers and vertical filled-in joints with decompression channels insulated with elastic gaskets and sealing mastics.

There is a tendency to use, in large-panel construction, volumetric elements with a high degree of prefabrication. Sanitary blocks fully finished and equipped at the factory are widely used in the USSR, Sweden and other countries.

Volumetric elements are also used for built-in balconies, staircases and other complicated components requiring the expenditure of much labour.

Experimental construction of residential buildings from volumetric blocks is carried out in the USSR. The degree of prefabrication of substructures in large-panel buildings usually is lower than that of superstructures. In many countries, substructures are built of in-situ reinforced concrete. In the Soviet Union and France precast elements are widely used for substructures. As experience shows, as a result of the use of precast elements, time-tables for the erection and substructures are 2–3 times shorter and outlays of labour are 30–40 per cent smaller.

### Industrial basis of large-panel construction and methods of production and building

During the first period the manufacturing of large panels was carried out both at yards and at industrial enterprises. At present large panels are fabricated predominantly at specialised house-building plants. Today in the Soviet Union there are over 200 specialised plants producing sets of prefabricated concrete for large-panel buildings. About 100 of such plants are in the process of construction. The large number of house-building plants made it possible to organise the serial production of equipment for these enterprises and to build them according to standard designs. In France more than 20 large-panel house-building factories and the great number of casting yards are now in operation. The considerable number of factories and yards have also been built in other countries.

Building details are produced either fully at house-building enterprises which facilitates the complex supply of products, or on the basis of co-operation of different specialised factories. In a number of cases it might be expedient to combine both ways by means of supplying house-building enterprises with mass standard production from specialised factories.

In many cases the erection of large-panel building and other building works is done by building organisations which receive elements from house-building factories. In the view of some specialists such a system ensures high demand on the part of organisations erecting buildings. It promotes the improvement of quality of the fabricated products.

However, the majority of house-building enterprises in the Soviet Union, France and other countries carry out both the prefabrication of building details and the assembly of buildings. These enterprises are called house-building combines. Specialised organisations are sometimes invited to do some kinds of jobs (earth works, roofing, finishing, canalisation) on the basis of sub-

contracting. The experience shows that this method allows to integrate the production of building details with the process of erection, and to achieve considerable success in further perfection of structures of large-panel buildings and production techniques. Moreover in such a case, when the prefabrication of details and assembly of buildings can be considered as continuous, better economic results are obtained. To ensure the profitability of house-building plants, it is necessary to unify their output. The unification of products is carried out on the basis of standardisation of structures and lay-outs.

In some cases the standardisation of lay-out schemes is limited to an isolated project. However, standardisation on a national level is most profitable. In the Soviet Union, Czechoslovakia and some other European countries, large panel housing is carried out according to standard designs. Standard designs are worked out to state orders in the form of series, including designs for blocks of different height and length, with different facades and lay-outs and with flats for different families. Such series are worked out taking into account different natural and climatic conditions and architectural and aesthetic requirements.

Standard drawings are prepared for separate structures and details. In the Soviet Union the standardisation of prefabricated parts for large-panel construction is being developed. The state standard determines the main technical demands of designing, manufacturing components and erecting large-panel buildings. When standard designs are worked out in series the requirements of standardisation can well be combined with the requirements of urban development provided, of course, that the quality of the project will be high enough.

The techniques of industrial production of large panels are being constantly improved.

The widely spread stand method of manufacturing panels in open yards, is being replaced with production-line and conveyor methods at the plants with automation of several operations. Mechanised cassette installations ensuring high quality of surfaces are being increasingly used. In the USSR a new method of mass production of large panels at vibro-rolling installations, (system of engineer Kozlov), is being increasingly used. This method ensures the continuity of production process and high productivity.

In most cases the assembly of large panel blocks is carried out by means of the "from wheel to place" method, without organising intermediate storage of building elements on sites; it ensures saving precast units from damage and speeding up the erection as well.

Much attention is being paid to the precision of fixing panels in the process of assembly. In the USSR, Denmark, Sweden and other countries the methods of the precise ("compulsory") assembly of large panels with the use of special conductors, fixing bolts and inserts have been worked out. These methods promote the higher quality of large-panel construction.

### Ways of further perfection of large-panel construction

Fast development of large-panel construction requires the co-ordination of efforts of specialists of all countries in order to solve a number of important questions determining the further perfection of large-panel construction and increase its technical and economic efficiency. Some of these questions were discussed at the CIB Commission W19 meetings in Paris and Stockholm.

The following recommendations are suggested for discussion at the Congress;

1. The main trend in the further increase of the efficiency of large-panel construction should be to raise the degree of prefabrication of elements by means of their complete finishing and equipment at the factories, the enlargement of products and use

of volumetric elements. To make this possible, it is necessary to solve the problems of transportation and assembly of enlarged elements with a high degree of prefabrication. Further research be undertaken on structural, technological and economic aspects.

2. The higher degree of precision in manufacturing and assembling large panels should promote the higher quality of construction and its economic efficiency. Therefore the questions of establishing suitable tolerances and the methods of control in the process of manufacturing moulds, the prefabrication of elements and erection attracted the attention of CIB Commission W19. It would be expedient to study the question of the unification of tolerances for the fabrication and erection of large-panel buildings, and the manufacture of technological equipment on the international level.

3. The wider use of new synthetic materials for finishing panels, thermo-insulation and especially for the sealing of joints between exterior wall panels would promote greater efficiency and better quality of large-panel construction. Research on new building materials should be concentrated on their durability and the most rational ways of their use.

4. The structural systems of large-panel residential buildings designed for mass construction can be considered settled. Research should be carried out on rational structural systems for large panel high blocks, blocks of flats to be built under complicated climatic and geological conditions, and completely prefabricated social buildings.

These studies should include the analysis of the durability and deformation of structures under uneven precipitation, seismic and temperature influences. Further perfection of the joints of panels is needed in order to ensure their durability and reliability, in particular, in the case of panels of light-weight or cellular concrete, where the question of the necessity of profiled jointing has not yet been settled.

5. The cassette technique and some other methods of manufacturing panels have been worked out. Research should be undertaken on the development of the vibro-rolling technique and other new methods, which promote the greater mechanisation and automation of production processes.

It is also necessary to make technical and economic comparisons of different methods of organising the prefabrication of elements and erection of buildings.

6. The problem of high architectural quality of large-panel construction when prefabricated standard elements are used, is one of the most acute importance. From the technological point of view it is necessary to settle the question of profitable fabrication at house-building plants of a developed series of large-panel buildings including blocks of flats of different height and length and fully prefabricated buildings for social services.

From the architectural and town-planning point of view it is necessary to work out the ways of adding variety to prefabricated houses with the limited nomenclature of products and the ways of building complexes in which prefabricated houses should not produce the impression of monotony, thus lowering its architectural and aesthetic level.

Problems of an architectural and town planning nature can be successfully solved only in co-operation with the International Union of Architects.

Up to the present time the questions of large-panel construction have been examined mainly by CIB Commission W19. The contribution of other Commissions in solving this important problem is needed. It would be expedient to charge Commission W19 with working out and submitting to the Executive Committee of CIB a programme of international co-operation and exchange of information in the field of large-panels construction. The programme should provide for the participation of other CIB Commissions, which can contribute in solving this problem.