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OUTLOOKS FOR THE DEVELOPMENT OF INDUSTRIAL CONSTRUCTION IN THE USSR 1/

by

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THE DEVELOPMENT OF INDUSTRIAL CONSTRUCTION IN THE USSR

Introduction

The enormous scale of capital investment in the USSR is not only many times greater than the volume of investments in the capitalist countries of Europe, but in many sectors also exceeds the investment rate in the most highly developed capitalist country, the United States. The Soviet Union has created an extensive building industry, a powerful construction-materials supply industry, as well as an advanced and highly versatile machine-building sector – in other words, a group of investment industries constituting the basis of the Soviet Union's economic growth through the broad-based application of the latest achievements of science and technology.

The underlying element in the development of the Soviet economy is the implementation of long-range programmes conceived for a period of 10 to 15 or more years. The planning of these long-term programmes is based on scientific forecasts of technological developments and on general schemes for the development and siting of industrial branches, regions, industrial centres and the like. Strategic planning of capital investments is tailored to meet these long-range development goals and establishes the proper sequence in the implementation of the associated programmes.

As the national economy continues to evolve, many modifications become necessary in the relative contribution of different production sectors, new branches must be created, obsolete machinery must be taken out of service and capital investments must be concentrated in the required areas. Such changes are initiated only after careful analysis in order to ensure that new building programmes are not held up because the modifications introduced have resulted in a diversity of requirements and expenditures not easily satisfied at a single stroke.

The structure and orientation of capital investments and of capital construction is largely determined by technical progress.

Increasingly large sums are being invested in what are known as scientific-industrial complexes, including investments in experimental plants and production areas, test ranges and facilities, laboratory buildings, drafting and design offices, control and test stations, automation and instrumentation maintenance services and also computer centres equipped with electronic data-processing systems. If improved returns on invested capital are to be secured, these scientific-industrial complexes must be efficient, equipped with modern machinery and instrumentation, capable of producing goods on a par with current world-wide standards, and used for their design purpose.

Invention and patent holdings, standard plans original building and design techniques and new methods for the structural arrangement and architectural layout of buildings and structures are acquiring especial significance. Documentation of this kind is of great value in the allocation of capital investments.

An important investment trend has to do with plant retooling, the renewal and updating of equipment and machinery and, finally, the rational redesign of production enterprises. This involves, primarily, the formulation of effective approaches to modernization, entailing the elimination of bottlenecks, the addition of new equipment, the introduction of more advanced technologies and the like.

The following considerations are fundamental, in this context, to the selection of regions and sites for the construction of facilities for different branches of the national economy:

- The improvement of the ratio of capital investments as between new construction on the one hand and the expansion and technical refitting of already existing enterprises on the other, taking into account the objective of equalizing the level of social development of the country's different economic regions;

- The extensive economic utilization of the most effective natural resources;

- The rational use of manpower resources in the different economic regions;

- Increased emphasis on specialization and the all-around economic development of the regions, together with the improvement of regional and interregional channels of communication;

- The intensification of capital investment in the service sector;

- The development of a systematic approach to community planning, including the regulation of the growth of large cities and the enhancement of the importance of medium-sized and small cities;

- The zoning of agricultural production according to country's climatic and economic regions;

- The integrated use and conservation of natural resources, particularly water, and the improvement of water-management operations on the part of the Union Republics and economic regions;

- The further expansion of the transport network, especially in the newly opened up regions; the development of railroad, highway, river, maritime and air transport to cope with the increasing volume of freight and passenger traffic.

By implementing these principles it will be possible to take into fuller account and more effectively exploit the natural and economic features of the various regions of the country and to achieve a more effective balance in social and economic development.

The expansion of the construction industry and the proper location of its activities constitutes a vital factor in ensuring the desired growth rates for the productive base of the Soviet Union, physically distributed in accordance with the principles established. This also means that measures must be taken to provide for the advance development of both the production infrastructure as well as housing and community services for the purpose of attracting and holding skilled workers in these communities.

Let us turn our attention to the development trends in the basic areas of construction activity - namely, those which are essential to the comprehensive development of the existing, and the creation of new, economic regions.

DEVELOPMENT PROSPECTS IN TRANSPORT CONSTRUCTION

The structural improvement of the Soviet economy requires that those branches which are engaged in technically re-equipping the national economy and in overcoming any lag in the development of agricultural production should grow at a faster rate than certain other sectors. One such area where an accelerated rate of expansion is required is transport.

The priority development of transport facilities is particularly important in regions under intense development and also when tackling the task of equalizing the levels of economic development in different regions of the country. This fact in large measure explains not only the technical and economic, but also the social significance of transport.

Studies conducted by a number of research institutes working in the field of transport problems have projected the tentative growth levels to be set for the country's major production items 15 to 20 years in the future and have defined the prospective total increase in haulage operations for all forms of transport. The evidence indicates that it will be necessary, over the next 15-20 years, to build several hundred thousand kilometers of primary and secondary highways, new railroad lines and second tracks, and long-distance pipelines. This same period will also see a need to modernise a large number of major highways and rail lines. In addition to this enormous scale of surface transport construction work, significant efforts will also be called for in the construction and modernization of sea and river ports, airports and air strips, pier and berthing facilities, transport centre and the like.

In continuing to upgrade the technical aspects in the key areas of transport construction the aim is a transport system of greater capacity and flexibility to meet the country's needs on time and without disruption, to ensure faster freight deliveries and passenger service, and also to create reserve operating capacities in this sector.

It is these general goals that determine the formulation of technical policy and the overall long-range development of the major types of transport construction.

Railroads continue to maintain their primacy in the transportation sector, particularly for the movement of massive freight shipments and heavy passenger traffic. Given these conditions, the railroad system will continue to grow, functioning as a basic network linking together all other modes of transport.

Increasing freight-handling operations, faster rail traffic and greater train weight are making sharply increased demands on the strength and stability of the track system. As a result, a set of measures has been adopted to meet the railroads' ever-increasing operating requirements regarding roadbed strength and safety. These measures include the development of industrial designs for the reinforcement of roadbed embankments and the implementation of preparatory work aimed at improved methods of laying roadbeds in dry and permafrost regions.

The increased weight and speed of the rolling stock calls for stronger upper track structures, a requirement that can be met through the use of reinforced concrete ties, unbonded track and heat-treated rails, as well as by increasing the degree of mechanization of track laying and maintenance operations. Like the highly developed capitalist countries, the Soviet Union is engaged in an intensive study of the problems of increased railway speed. The maximum speed attained in the USSR is 160 km/h on the Moscow-Leningrad line. At the present time, technical specifications are being developed for the planning of new rail lines designed to handle passenger trains at speeds of 250 km/h.

Highway construction and increased automotive production has resulted, over the last 15 years, in a 7-fold increase in over-the-road freight handling and a 23-fold increase in passenger traffic (for bus transport alone). The next few years will witness an increase of several hundred per cent in the volume of motor vehicle transportation and even greater increases in the number and traffic density of private cars.

At the same time, however, the automobile highway system in the USSR is less developed, and its technical level lower, than in the industrially advanced countries. The percentage of roads with high-quality surfacing is inadequate.

To provide the country with well-built roads there is to be a substantial increase in the construction of new major highways and hard-surfaced secondary roads.

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This road building and reconstruction program envisages the following measures:

- The application of new high-quality road-building materials incorporating asphalt and cement-concrete mixtures as well as the more extensive use of locally available low-cost materials derived from blast-furnace and other slags;

- The extensive use of products from the chemical and petroleum-refining industries;

- The introduction of new long-life, high-quality road surfacings: long-line tensioned concrete, self-tensioning concrete surfacings, packed-earth foundations and foundations consisting of stone-crushing and metallurgical waste materials.

The technical level attained by the USSR in the construction of prefabricated reinforced-concrete bridges and bridge supports in the USSR is now on a par with that of other advanced countries. The establishment of a domestic industrial base for the production of precast reinforced concrete and a major research and development effort mounted in the laboratories and at the building sites have made possible the application of many new approaches never before used anywhere for the design of spans, support structures and foundations, their construction technology and the special equipment used to build them.

Technical progress in the field of bridge-engineering is characterized by the following trends.

In civil engineering works on new and existing railroads and highways, steel and reinforced concrete spans will be used for railroad bridges with span lengths of 44 meters or more, and for highway bridges with span lengths of more than 100 meters.

In the construction of metal span structures for railroad and highway bridges there is to be extensive use of low-alloy and heat-tempered steels, high-stress bolts for sectional assembly, electrically welded joints and a number of other modern building techniques.

Highway and railroad bridges with span lengths of less than 100 meters are to be built mainly with reinforced concrete.

In remote or thinly populated areas as well as in northern and wooded regions, steel will be widely used in addition to concrete for railroad bridge engineering, while highway bridges will be constructed with structural elements of glued wood and other effective types.

An important advance in the construction of [illegible] as much as 50 per cent of the entire work volume in civil [illegible] construction projects, is the introduction of corrugated metal structural [illegible]. In comparison with the consumption of steel for ferroconcrete tubing and [illegible], steel consumption for corrugated metal piping is [illegible] per cent lower, costs are [illegible] per cent lower, labour expenses are from 65 to 70 per cent lower and structural weight is [illegible]0 per cent lower and more.

Underground-railway construction in the USSR is not only on a par with current technical standards, but in many areas is more advanced than in the capitalist countries. Its development has been marked by increasing reliance on industrial tunnelling methods using precast ferroconcrete structural elements, greater mechanization, the introduction of mechanized heading machines and the achievement of higher tunnelling speeds.

During the last ten years some 70 per cent of the length of all tunnels drilled in the USSR has been lined with precast reinforced concrete, while the use of iron has been cut back by 75 to 80 per cent.

Key elements in further upgrading the engineering aspects of underground-railway and tunnel construction are to be the improvement of existing structural members, heading machines and tunnelling mechanization facilities, and the creation of altogether new systems in these areas.

With respect to improved structural members, here the outlook is for more extensive use of precast ferroconcrete and totally prefabricated structural members, with particular attention to the following:

- The use of cost-effective and durable stage tunnel linings of precast ferroconcrete embedded in the living rock;

- The substitution of precast ferroconcrete for iron tubing in tunnel linings on runs where the hydrogeological conditions are difficult, resulting in a saving of 4,500 tonnes of metal per kilometer of tunnel through the use of impermeable structures water proofed at the producing factory and by sealing the lining seams with water-tight mastic cement;

– The use of larger precast reinforced-concrete [illegible] for [illegible]-work stage tunnels, employing factory-[illegible] fireproofed prefabricated tunnel sections of [illegible] "gidrostekloizol" and polyethylene (thereby permitting a [illegible]-per-cent reduction in the labour required for tunnel construction).

The major trend in the mechanization of tunnelling operations is the transition to the use of mechanised loading equipment for driving stage tunnels, with additional apparatus for the mechanization of all subsequent operations (tunnel transport, forced treatment of seams, etc.). This will make it possible to reduce the amount of labour required to drive 1 km of tunnel by [illegible],000 man-days (from the [illegible],000 man-days required at the present time).

For the mechanization of mountain tunnel construction builders will draw on the experience they have gained in the driving of underground railway tunnels, a primary concern here being the development of an industrial technology to permit considerably faster advancing rates.

During the 1954-1970 period there was an increase of several hundred per cent in the construction of harbour works. Nevertheless, the USSR continues to lag behind a great many foreign countries in the overall extent of its sea and river berthing facilities.

Recent years have seen a substantial improvement in the technical calibre of harbour construction. The use of prefabricated elements for port facilities has reached 70 per cent, while the cost of labour in the more difficult categories of work is down by 15-20 per cent. New and advanced high-efficiency floating installations have been put into operation, along with the introduction of a number of effective money-saving technical innovations – underwater television systems, vibrat[illegible] compactors for use with stone flooring and the standardisation of a number of structural members.

Soviet techniques for protecting coastlines against the effects of erosion are no less advanced than those used in other countries.

In the area of shore-strengthening operations along sea coasts prefabricated large-section structural members have been introduced for built-up jetties and breakwaters to protect a number of shoreline segments of the Black Sea.

To prevent any imbalance from occurring between the sharply expanding carrying capacity of the merchant fleet and the handling capabilities of the harbours and ports, a major effort towards the construction of [illegible] facilities has been scheduled for the period from [illegible] to [illegible].

There is to be a further upgrading of the technical level in harbour water-engineering works through the design of new cost-effective and long-lasting deep-water pier and breakwater structures, technological improvements and comprehensive mechanisation of loading and unloading operations, with particular attention to the following requirements:

- The introduction, after tests have been completed, of a proposed new floating facility - a breakwater with wave-quencher - which will enable harbour construction workers to continue working even in the face of storms measuring 5 points on the intensity scale (the present operational limit for floating equipment is 2 points);

- The putting into production, following the completion of research, of a pier design rated for depths of 13.5 to 20 meters using large-diameter shells;

- The mechanization and partial automation of underwater engineering operations in order to limit or completely eliminate the difficult and hazardous work of divers.

In the interests of accelerated technical progress, better planning and more effective management of construction activities in the transportation sector, it is intended to make the fullest use of economic-mathematical methods, computerization and communication facilities.

DEVELOPMENT [illegible] INDUSTRIAL [illegible]

A characteristic feature of modern industry is the continuing improvement of its technological processes, the creation of new kinds of equipment of every type, the elaboration of highly sophisticated assembly line procedures and the manufacture of more and more new product lines. All this has an effect on the buildings and facilities that are to be planned. Shorter lead-times for technological processes coupled with the availability of equipment of constantly increasing efficiency require the design of new, versatile types of buildings and installations in which the need for reconstruction will be held to a minimum.

In terms of the nature and essential features of what they produce, industrial enterprises fall into two categories:

- Enterprises which can be located within city limits,

- Enterprises which must be located outside city limits and occasionally at considerable distances from them.

The first group includes enterprises which do not generate harmful waste materials, do not emit annoying noises and vibrations, do not involve heavy amounts of freight traffic and which, as a rule, employ equipment which does not give rise to severe structural stress (radio and electronics, instrument-building, precision engineering, light industry, food industry and certain other industrial branches). Enterprises of this category have very definite requirements with respect to flexible floor space planning and building design to permit frequent process modification and retooling without major changes to the premises.

Enterprises of the second category show a tendency towards an increase in the size of their processing units, for which special-purpose buildings are then allocated. Such enterprises include firms working in the areas of mining, iron and steel, basic chemistry, heavy machine-building and others.

By locating enterprises within city limits the national economy is assured certain significant social and economic advantages since workers now enjoy a substantial reduction in commuting time to and from work, in addition to which conditio are created whereby the industrial facilities and the city can share all utilities and engineering services (water, power and the like) and there is less need for city transport and for the funds required to expand its operation.

Even now non-polluting enterprises have been developed in a number of sectors - electronics, instrument-building, precision mechanics, textiles, clothing, etc. Improved technological processes, hermetically sealed equipment, effective systems for the purification and containment of harmful wastes and effluents are increasingly expanding the range of enterprises in various sectors of industry which may safely be located within municipal limits in what is certain to be the trend of the future. With each year more and more enterprises will fall into this category.

The direct involvement of these enterprises in research and development activities, as well as the absence of any severe stress and vibrations, is likewise a determining factor in selecting the type of buildings which they require - primarily multi-storey, of pronounced architectural style and with large clear areas between columns.

By using multi-storey buildings of great height and width, several different production activities or even enterprises can be accommodated in a single building by partitioning it off into vertical and horizontal sections.

The clear areas between columns found in today's multi-storey buildings (6 x 6 and 6 x 9 m) are no longer adequate to the needs of many production activities which might otherwise be housed in multi-storey buildings erected within city limits.

The single-storey buildings now being built for these activities feature bays measuring 12, 18 and 24 meters.

While today's architectural designs call for an area between columns of 12 x 6 m, by the year 1990, together with the existing structures, multi-storey buildings will be erected offering clear areas of 12 x 12, 18 x 6, 24 x 6 meters - and possibly even larger ones - which will substantially enhance the versatility and universality of these buildings.

Despite the increase in the proportion of multi-storey buildings for industrial purposes, the predominant type will continue to be one-storey structures, which, besides the commoner all-purpose types, will include:

- Single-storey buildings with a [illegible] storey;

- Single-storey buildings with an [illegible] storey between the trusses.

The presence of an engineering (technical) storey will make it possible to isolate dirty and dust-raising processes, install mains and distribution lines and service them more easily, achieve maximum efficiency in the location of auxiliary services and the utilization of building floorspace, ensure substantially improved working conditions and the like.

Computations have shown that for buildings with a ground floor (as opposed to single-storey buildings) site coverage is reduced by 2[illegible] per cent and cost by 5 per cent, to say nothing of the gains derived from the flexibility of such structures resulting in longer service life before they become obsolescent.

A very promising innovation can be seen in buildings constructed from film (sheeting) or fabric material using pneumatic-frame, compressed-air or tent-type (hipped) design, the distinguishing features of which are very short erection periods, low specific weight per square meter of floorspace, plus simplicity and ease of transportation and assembly. Such buildings are destined to gain fairly wide acceptance, especially for activities in which work is of a seasonal nature (the primary processing or storage of cotton, fruit, vegetables and the like).

For certain production activities, storehouses and repositories it may be expedient to use existing or newly developed underground workings. Such underground areas are primarily suitable as sites for production activities which employ a limited number of workers and which turn out a product which might be damaged by vibrations, where equipment is to be installed directly on the ground and where stable temperature and humidity conditions are required in the production areas. Since there is no need to construct expensive buildings in mine locations of this type, the economic advantages of this solution require no commentary.

The principal approach towards the improvement of single-storey structures is through increased unit space (by rational floorspace layout), bays and clear areas between columns, a wider use of suspended ceilings, and also a greater reliance on unheated buildings and windowless structures.

For example, [illegible] 11 [illegible] it is possible to reduce the [illegible] by [illegible], the [illegible] buildings by a factor of 3 to 5 and the standard dimensions of [illegible] structural members by a factor of more than [illegible]. [illegible] 10-to-16-per-cent reduction in construction [illegible] per cent reduction in overheads.

By increasing the intercolumn area in the building to 1[illegible] x 1[illegible] and [illegible] x 24 m, with mutually perpendicular movement of cranes of up to 1[illegible] tonnes lifting capacity, better organization of technological processes is made possible, although these buildings are no more expensive than those designed with conventional column spacing.

One result of this trend toward buildings of larger size to permit the rational distribution of production activities both vertically and horizontally, the use of underground areas and the introduction of ground-level and inter-storey engineering floors will be to increase the number of windowless buildings using artificial illumination, the properties of which, as time goes on, will more and more come to resemble those of natural light.

The use of artificial lighting makes possible not only the unlimited increase of the width of single-storey and multi-storey structures, but also the location of a part of the production areas on the underground levels of combined industrial-residential complexes.

A very promising trend towards better industrial construction has to do with the amalgamation of enterprises into groups (industrial centres) sharing common transport and engineering systems, repair and warehousing facilities and communal and amenity services for the working population. Depending on actual conditions, this yields a reduction in construction and assembly costs of 6 to [illegible] per cent, a decrease in annual overheads of 2 to 6 per cent, a cut-back in manpower of 2 to 5 per cent and in plant area of 15 to 50 per cent, and a shortening in the overall length of transport and engineering systems of 10 to 40 per cent.

The key to better, less costly and more light-weight shell structures for industrial buildings consists in the substitution, for the traditional heavy armoured-concrete facing slabs, of shaped steel flooring as well as panelling, flooring and sheeting of aluminium, asbestos cement, [illegible] glass-reinforced plastics and other effective materials in combination with light-weight insulation with unit weights to 100 kg/m^3. These materials are most suited for building construction in relat unpopulated regions which lack railway services and construction industry infrast ture, and also in areas with a [illegible] rating of 7 points and higher. When materials of this kind are employed, shell weight (including framework) can be redu by a factor of 6 to 10 with cost economies in the order of 1.[illegible]-10.0 roubles/m^2 depending on the region where the building is erected.

An additional means of reducing the cost and weight of shell structures is through the use of facing slabs of light structural concrete with a volumetric weig of 1,200-1,600 kg/m^3 and the replacement of insulators consisting of light and cellular concrete having a volumetric weight of 400-600 kg/m^3 with insulators of polymer and other light materials with volumetric weights to 100 kg/m^3.

In addition to the use of totally factory-prefabricated panelling of light an cellular concrete, another approach to lower costs and reduced labour expenditure i the erection of outer walls of enhanced architectural and aesthetic quality is thro the extensive application of aluminium, steel and asbestos-cement structural member coloured glass panelling, polymers and other materials.

To facilitate the internal reorganization of buildings when modernizing production technologies, there will be increasing use of dismantable partitions with steel and aluminium framework and sheet insulation, as well as of sectional partiti of heavy and light concrete, glass-reinforced plaster, cellular plastic and other materials.

One important way of increasing the industrial versatility of single-storey b ings is the use of stress-rated flooring to permit the installation of heavy equipm as well as its replacement and improvement at a later date without affecting the foundations.

The structural support members of industrial buildings and structures are, and will continue to be, produced from steel and ferroconcrete.

All-purpose multi-storey buildings which may be used for different purposes i the course of time and which offer many decades of service life before becoming obsolescent are normally constructed out of reinforced concrete.

In single-storey buildings and structures – especially those which are put up for specifically defined production activities and technological processes which become obsolescent relatively soon – it is advisable to employ steel framework so that the buildings can be used again for other purposes.

The use of steel, asbestos cement, aluminium and other light-weight materials for the shell structures of buildings results in sharply reduced loads on the support members of the framework. For this reason, in buildings with light-weight facing – where the latter weighs up to 100 kg/m^2 – the rafters will be of steel, whereas in structures where both the facing and walls consist of some light-weight material, all-steel frameworks will be employed. As a result of this measure, 50 to 60 per cent of all single-storey buildings will be constructed with steel frames.

Major factors in the more extensive use of steel structural elements are the greater availability of a wider range of rolled iron-and-steel products (hot-rolled and welded wide-flange I beams, cold-bent shaped sheeting material of from 0.8 to 1.2 mm in thickness, welded pipes for structural applications, etc.) and the increased use of improved-strength and high-strength steels for lower steel consumption and reduced construction costs.

The trend in precast ferroconcrete structural elements is towards improved design (e.g., the substitution of I beams for rectangular girders and columns), lighter weight (through the introduction of high-strength concrete types – the heavy M 600-800 and the light M 400-500 with unit weights up to 1,600-1,800 kg/m^3) and a higher degree of factory prefabrication coupled with greater suitability for industrial production. For the armouring of prestressed members, it is planned to make extensive use of high-strength cold-drawn wire, braiding and cables, as well as low-alloy and heat-hardened indented steel shapes and wire rods.

Wooden support and shell elements are used in structures of 1 or 2 bays built in areas where there is a surplus of lumber and also in buildings and structures in situations where there is a danger of corrosion by salt and certain other chemicals and where wood affords considerably greater durability than either metal or reinforced concrete.

An area in which major technical progress is being achieved is that of improve design standardization. Given today's rapid tempo of technological advance in indus and in the building sector, the further standardization of the floor space arrangem and structural features of buildings and edifices along with the development of sta plans and materials (standard scale drawings, standard sections, structural element parts, components, etc.) must be seen as a trend of fundamental importance.

When standard techniques are employed in the planning of industrial facilities, very attractive opportunities arise for the use of new and advanced technological approaches, for co-operation between different industries, for the erection of large buildings and for grouping them in line with the general functions of the tenant enterprises and into industrial centres, and for taking into account the extent and relief of the construction site, its hydrogeological conditions and the scheduling of construction. At the same time, this approach also makes it possible to ensure the necessary conditions for bringing the construction effort up to industrial stand and for shortening the planning period.

The elaboration of comprehensive standard plans can be recommended whenever the is a need for the repeated use, over a relatively brief time interval, of enterprise shops, etc. of the same type and of definite capacity (as, for example, in the food industry), and also when erecting auxiliary structures (pump houses, lubricant and chemical storage areas, petroleum product depots and the like).

Comprehensive standard plans should be drawn up on the basis of standardized outline drawings drawn to scale and standardized sections using standardized structu elements and parts.

DEVELOPMENT PROSPECTS IN RURAL CONSTRUCTION

The expansion of construction activities in rural locations is aimed at:

- The long-range development of a network of rural communities;

- Ensuring a level of cultural and communal services and public amenities on a par with those found in the cities.

It is the role of regional planning to establish the most effective capacities of collective and State farms, to promote the specialization and concentration of production and to make provision for large-scale manufacturing complexes on an industrial basis.

In the interests of the more effective use of agricultural raw materials, manpower and farm machinery in rural localities, it is intended to establish industrial enterprises for the processing of agricultural products, crop distribution centres and agro-industrial complexes. The implementation of these measures will make it possible to reduce losses of highly perishable products poorly suited to transportation by a factor of 3 or 4, to increase by 20-25 per cent the utilization of manpower resources and to cut back by 12-18 per cent one-time capital investments and by 8-12 per cent annual expenditures for the construction and operation of industrial and agricultural facilities.

Rural community planning is based on functional principles of village zoning, the development of housing complexes, the establishment of public centres, the laying out of streets and industrial building sites and the like.

The plans include measures designed to guarantee a satisfactory level of creature comforts for rural populations, rational technological and functional links and lower capital investments.

At the present time, rural construction using fully prefabricated elements is insufficiently developed and accounts for only 5-10 per cent of all construction activities. This area is to be considerably expanded and by 1975 should stand at three times its present level.

Fully prefabricated industrial building designs rely on the use of precast reinforced concrete in combination with effective light-weight materials: steel, aluminium, foam plastic, structural asbestos-cement sheeting, glued wood, and the like.

In the construction of livestock-breeding complexes the most common approach consists in the use of reinforced concrete piles and columns, metal girders, wall facing and roofing of asbestos cement laid on a wooden framework, and mineral wool insulation.

Another good solution makes use of a ferroconcrete half-frame for an 18-metre bay with triple-layer "sandwich-type" wall panelling consisting of two layers of reinforced concrete and a foam-plastic insulation layer.

Finally, extensive use is to be made of frame-type structures with large light-weight concrete panelling. Initial experience with light-weight materials and structural elements has demonstrated their many advantages: a 3.5 to 4-fold reduction in the weight of the structure coupled with a 2.5 to 3-fold decrease in the labour, and a 2-fold decrease in the time, required to build it.

In the area of grain elevator construction the outlook is for new high-capacity complexes (above 50,000 tonnes) embodying a high degree of mechanization for grain reception, drying and unloading operations. Tower-type elevators will come into wide use, as well as elevators with no levels above or below the silo and designed of prefabricated metal and reinforced concrete rings of large diameter (more than 9 metres) and also three-dimensional reinforced concrete elements with single and double armouring.

Also to be built are frame-type silos with reinforced concrete panel lining. In comparison with elevators of cast-in-situ concrete, fully prefabricated elevators of light-weight design will make possible an 8-15 per cent reduction in construction costs and a 30-40 per cent drop in the consumption of concrete and steel.

Granaries are to be built in the form of ground structures with no internal supports but using frames, arches and vaults.

For mineral fertilizer storage areas it is planned to erect barn-like structures mainly without internal supports, having bay lengths of 18 m and with heavy reliance on glued wooden frames. Granulated and powdered mineral fertilizers will be stored in silos of precast reinforced concrete or metal measuring 6 to 9 metres or more in diameter.

Construction of storage areas for vegetables and potatoes must be of the high-capacity bulk type - for 5,000 tonnes and above - using precast reinforced concrete structural elements.

The greenhouse structures to be built are to be extensive - covering 120,000 to 1?0,000 m^2 and above -- using advanced design concepts. Recommendations call for the erection of hangar-type winter greenhouses in northern and central areas and of block-type spring greenhouses with covers of plastic sheeting material for southern areas.

A major concern at this stage in the development of a rural construction infrastructure is the creation of a fully prefabricated construction support industry or base. There are certain distinctive features in a base of this kind under rural conditions: the enterprises are smaller than those found in the cities; their product line must, because of transportation considerations, be more light-weight and the most effective materials must be employed; the plants must be designed to ensure the comprehensive development of the communities within a given zone and to provide for the erection of all types of buildings. The solution of these problems in rural areas has led to the emergence of a particular type of enterprise - the rural construction combine (RCC). One version of these combines specializes in the annual production and assembly of 100 agricultural production buildings. In terms of design, these buildings feature precast reinforced-concrete pile-columns, panelled cladding elements consisting of large asbestos-cement sheets and mineral wool insulation, and steel roofing girders. For the construction of swine and cattle areas the combine produces wall panelling consisting of two layers of heavy reinforced concrete and an insulation layer of foam polystyrene.

Another, all-purpose, PSS type has been developed to turn out complete sets of structural elements for residential, public and production-oriented buildings. The combine's annual production capacity of 100,000 m^2 of structural elements yearly - of light and heavy concrete - is sufficient to meet all rural building needs within the ?-km radius judged to be optimal for automotive transport.

By selecting enterprise sites in accordance with previously developed planning, by designing these enterprises for optimal production capacities, and by co-ordinating the efforts of State and collective-farm construction organizations, rural building agencies in the USSR are today creating a powerful production infrastructure to ensure increasingly wider use of industrial methods in the construction sector and to make possible faster progress every year in the transformation of the countryside.

DEVELOPMENT PROSPECTS IN THE PRODUCTION OF STRUCTURAL ELEMENTS AND BUILDING MATERIALS

The building materials industry forms a part of the material and engineering infrastructure of the construction sector. This fact explains the following characterisitc features of this branch:

- The goods produced by the branch are overwhelmingly used to replace and add to basic capital assets;

- The qualitative and quantitative requirements of the branch are determined by construction-related considerations;

- The branch consists of a conglomerate of subsidiary branches and production activities which are normally not technologically interrelated;

- The goods produced by these subsidiary branches and production activities can be grouped together according to some functional criterion, such as roofing materials, flooring materials, binding agents, wall materials and the like;

- Within the groups there is regularly found an extensive interchangeability of product line.

Preliminary data indicate that the next 15 to 20 years will witness radical and forward-looking changes with respect to engineering, technology and structures within the functional material groupings discussed above and in the quality and range of available products - with all this to be based on the practical use of the latest achievements in physics, chemistry and the other fundamental scientific and technical disciplines.

<u>In the cement industry</u> not only is there to be an increase in the capacity of th basic equipment, but fundamentally new methods and techniques are also to be introduc suspended-state and live-bed firing of clinkers, the use of oxygen and other methods of intensified firing, the use of air-pressure mills and centrifugal-type pulverizers By the end of the period mentioned above fully automated cement plants are to be put into operation. More cement will be produced by the dry method using new types of kilns capable of producing up to 5,000 tonnes of clinkers per day. Higher-quality cement grades will be introduced and the production of white, coloured and special varieties of cement will be expanded to a level sufficient to meet the entire need of the economy for high-strength and rapid-hardening cements as a basis for the production of types "600" - "1000" concrete.

In the asbestos-cement industry, in addition to improvements in existing processes for the production of corrugated sheeting on wide-format sheet-moulding machines and of asbestos pipes, 6 and 4 metres in length, using newly developed pipe-shaping machines, new technological processes will also become operational: the production of flat structural and facing sheets by the dry-pressing and vacuum-force lamination methods, of heated slabs and panels by the vibratory-moulding and extrusion methods, of non-ramming pipes by the extrusion method, etc.

In the wall materials industry brick and other materials of small unit size are to be gradually replaced by light-weight panelling - particularly of the type containing effective heat insulation.

In the production of non-metallic materials and light-weight fillers it is planned to introduce a variety of high-efficiency equipment based on high-frequency electrical currents, laser radiation and the like. Production of finely crushed rock and graded sand will account for as much as 80 per cent of the total output of these materials. In the structure of concrete aggregates there will be a marked trend toward greater amounts of keramsite*, agloporite* and other porous materials.

In the glassmaking industry greater emphasis will be placed on the accelerated development of new materials (polished showcase glass, art glass, coloured translucent glass, block glass, shaped fibre-glass laminate and others).

Structural sheet glass will be produced both by the vertical working method and by the float process. It is intended that new facilities will eventually employ only float systems and new systems based on high-productivity forming processes. New equipment will be designed for the manufacture of glass-crystal materials (sitals) formed in a metal melt and crystallized in a gas-air "cushion".

In the structural ceramics industry the introduction of the new hydrostatic moulding technique will make it possible to automate labour-intensive processes in the production of wash stands, basins and sewage pipes. The industry will develop new products and will improve the design of sanitation fixtures, which will henceforth be manufactured exclusively from porcelain compounds. Production will be begun of large-size slabs, cerographically coated slabs for use as internal linings, and of slabs with fritted surfaces to be used in the external cladding of walls, alkali-resistant articles and the like.

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* Translator's Note - Light-weight porous fillers for concrete.

A wider range of rolled roofing and hydro-insulation materials will be availabl[e] in significantly better quality. By increasing the part by weight of the roofing pasteboard, upgrading the quality of the bitumens and dispersants, employing plasticizing additives and adopting other measures, it will be possible to extend th[e] service life of rubberoid to at least thirty years. A substantially expanded range o[f] mineral-based and neutral-based materials will be available for heat insulation and roofing to meet unusual environmental conditions.

Major changes have been planned for the polymer building materials industry. Special-purpose articles of standardized quality will be developed and the industry will expand the production of new types of sealing compounds, acoustic and thermal insulation materials, films and floor coverings. Improved technology and better-quality synthetic raw materials will result in polymer products of far greater strength, durability and cost-effectiveness.

Radical improvements in the technically related aspects of production have been planned for the other branches of the building materials industry as well.

DEVELOPMENT PROSPECTS IN THE SOVIET HOUSE-BUILDING INDUSTRY

Thanks to the implenetation during recent years of an expanded building programme n the Soviet Union, the housing situation has improved considerably.

During the 1966-1970 period the country built 11,347,000 apartment units with a otal area of 518,000,000 square metres, this being 27,600,000 square metres more than uring the preceding five-year period. This expanded programme was also marked by a rend, within the overall volume of housing construction, towards a heavier volume - n absolute and relative terms - of State-financed construction activity (63 per cent n 1970 as opposed to 51 per cent in 1961).

The Soviet Union has for many years been among the world's leading nations in he rate of construction and the number of apartment units made available per 1,000 nhabitants.

During the last five-year period (1966-1970) this colossal house-building effort as made it possible to improve the living conditions of nearly 55 million people, or ne out of every four families.

Just as during the preceding period, State and cooperative funds are being used or the construction, in cities and working communities, of large apartment houses lly equipped with plumbing, sewage disposal systems, central heating, baths or owers.

As a general rule, house-building in the new residential areas or satellite mmunities is co-ordinated with the construction of the necessary cultural and service cilities. The 1966-1970 period saw the construction of schools to accommodate 100,000 million children, kindergartens and day nurseries for 2,500,000 children, ops and stores providing 300,000 jobs, public catering establishments for 1,500,000 trons, and hospitals with a total of 30,000 beds.

Large-scale reconstruction is under way in the older regions of the cities, where ery year many dilapidated and antiquated apartment buildings are being torn down. so in progress is a broad-based programme for the reconstruction of rural communities med at doing away with very small inhabited settlements unsuited to further velopment and at creating in their stead village communities offering well-equipped dwelling houses and modern cultural and communal services. This expanded scale of home building has been stimulated by the introduction of industrial methods based on the use of standard house and house-component design and also on the use of precast reinforced concrete. A particularly sharp upsurge has been seen in the area of large-panel construction, which, measured against the total volume of State and co-operative-funded home-building, rose from 1.5 per cent in 1959 to 38 per cent in 1970. There a[re] now more than 300 large-panel home-building construction organizations active in the USSR, with a total yearly production capability of more than 36 million square metres of floorspace.

As indicated by the experience of the Soviet Union and other technically develop[ed] countries, house-building based on the use of large structural members results in significantly reduced labour and construction costs by comparison with traditional methods (according to United Nations studies, cost economies of from 10 to 15 per cen[t] can be realized with the large-panel system).

The transition to single-family occupancy of apartments in the new houses and the improvement of living conditions in older dwellings has made a major contribution towards the attainment of an important social goal set by the Government's programme [-] an individual apartment meeting all amenity and sanitary standards for every urban and rural family.

However, despite the considerable and constantly increasing volume of constructi[on] activities, there is still a housing shortage. For this reason, the Soviet Governmen[t] continues to attach the greatest importance to the fulfilment of one of its major social goals - the planned provision of modern housing facilities for the entire population.

The year 1969 marked a new and important stage in the development of mass house-building in the USSR. That year saw the decision not only to step up the volume of building activities, but also to upgrade substantially the qualitative aspects of large-scale house-building in the Soviet Union. To this end, specific objectives were laid down with regard to better quality in construction, assembly and finishing work and improvements in the planning of dwelling houses and apartments, their interi[or] finishing and equipment. Plans were approved calling for the transition, beginning in 1971, to new and advanced standard housing designs and the use of large-panel building techniques to account, by 1975, for as much as 50 per cent of the overall volume of State and co-operative construction activities.

The five-year plan for the development of the national economy for 1971-1975 rovides for the construction of from 565 million to 575 million square metres of ousing floorspace. As during the preceding periods, the housing needs of the Soviet ublic will be chiefly met through State-supported construction activities 2-65 per cent).

In recent years, home-building co-operatives have accounted for 6 to 8 per cent f all housing construction. Some expansion of co-operative home-building activities s planned for the current five-year period. The Government makes available to the ome-building co-operatives building sites on a no-charge basis and grants their embers loans amounting to 60 per cent of the cost of the apartment to be repaid over 0 to 15 years at an interest rate of 0.5 per cent (in the northern regions the amount f the loan and its repayment period are increased to 70 per cent and 20 years, espectively). Such co-operative-built housing is put up by State contractors at he same prices that prevail for State construction projects. An important contribution o the drive for better housing is also made by the individual building efforts of mall town and settlement dwellers using their own money and assisted by State loans. o such individual builders the Government makes available free sites and grants loans f 700 roubles over 7 years (certain categories of manual and office workers are ligible for loans of 1,000 roubles to be repaid in 10 years). This kind of construction ctivity accounts for some 33-35 per cent of home-building in the Soviet Union.

A major achievement of the socialist social system is the no-cost availability the public of Government-owned housing. The very modest apartment rents charged r the use of these housing facilities amount to only 4-5 per cent of the family's come and have remained stable over the last twenty or thirty years. A large part the maintenance costs for this kind of public housing is borne by the State, ich allocates more than 2 thousand million roubles for these purposes.

An important factor in ensuring the planned increase in home-building in the viet Union is the extensive use of standardized plans which are periodically updated evised) for the purpose of improving the convenience and comfort of the buildings.

In 1970 house-building based on the use of standard plans accounted for more an 90 per cent of the total volume.

To enable these standard plans to take fuller account of the whole range of loca conditions - geology, nature and climate, topography, national customs, demography, materials and technology, and the like - which have a bearing on construction, and also to provide structures of greater architectural and aesthetic diversity, the entire territory of the Soviet Union has been divided into 26 republic building-plan regions. For each such region, series of standard plans may be drawn up, differing in layout, wall materials, design and technical features etc.

For large cities where building activity totals not less than 500,000 square metres of housing floorspace per year, special series of standard plans are devised, whereas for residential regions with construction amounting to 50,000 to 100,000 square metres of floorspace annually the emphasis is on standard plan variants which make maximum use of items turned out by the local building industry.

A standard-plan apartment house series includes a set of standard house plans in addition to their co-ordinated three-dimensional elements: block sections (rows, ends and corners) and the build-in and build-on members for the final configuration of the houses - balconies, loggias, individual rooms, staircases, elevator shafts and the like. Normally, a standard plan series includes 4-, 5- and 9-storey houses; however, to give the complex a more definite architectural character, series may als be designed having houses of from 12 to 16 floors. In the case of plan series for houses to be fabricated from locally available materials, two-storey structures are included in addition to the 4-, 5- and 9-storey houses, as well as communal living facilities of 2 and 4 or 5 and 9 storeys. For average Soviet conditions the followi is the recommended ratio to be used during the current period in serialized residential construction (in percentages of yearly building activity):

Finished standard apartment-house plans	45-50 per cent
Partially modified standard apartment-house plans (alternative facades, incorporation of ground-level storeys where appropriate to terrain, etc.	25-30 per cent
House plans using block sections and built-in structures	20-25 per cent
Individualized plans	5-8 per cent

These ratios are offered as a guide and may be varied according to the actual capabilities of the construction region. In addition to the standard plans for residential housing there is also being developed a so-called "Nomenclature of Public Building and Structure Types". The building types included in this list correspond to the hierarchical cultural-and-communal servicing system devised in conformity with the planned approach to community structuring (micro-region, residential region, city, settlement, suburban zone).

The capacity of public buildings is determined on the basis of the following tentative community population capacity:

Micro-region - 6, 9, 12, 16 thousand inhabitants;
Residential region - 30, 45, 65 thousand inhabitants;
Settlement - 0.25, 0.5, 1, 3.5, 6, 9, 12, 16 thousand inhabitants;
Small city - 25-30, 35-40, 45-50 thousand inhabitants.

The standard plan list for public buildings to be erected in micro-regions ncludes alternative three-dimensional layouts for a variety of urban development onditions to ensure a diversity of architectural, compositional and aesthetic styles n keeping with the most effective use of capital investments.

The new standard plans, which began to be used by the construction industry in 971, have been designed to provide the public with apartments offering more living nd total floorspace per person. In conformity with the requirements of the new onstruction Standards and Regulations, the upper limit for total apartment floorspace as been increased and set according to the number of rooms. Apartments have been ategorized as "small" (A) and "large" (B), and the minimal living areas have been stablished for each apartment type (A and B).

Apartment layout has been improved in the new standard plans:

- There is an increase in the area of living-rooms (not less than 16 m^2 in -3 room apartments as opposed to 15 m^2, and not less than 18 m^2 in 4-5 room apartments) nd bedrooms (not less than 12 m^2 for the master bedroom for two persons as opposed o 10 m^2, and not less than 8 m^2 for the second bedroom for two persons as opposed o 6 m^2);

- Increases have been made in kitchen space (not less than 7 m^2 as opposed to 6 m^2), hall space (not less than 1.4 m in width as opposed to 1.2 m) and the size of sanitary facilities (bathtubs to be 1.7 m long as opposed to 1.5 m);

- Mandatory provision has been made for the incorporation of built-in wall closets and storage areas, as well as outlets for stationary kitchen appliances and modern sanitation and household conveniences;

- Apartment layout has been improved by the clear and functional delimitation of living and auxiliary areas.

The new standard plan series are designed to provide apartments to meet the need for rational accommodation for single persons and families of different size. This is to be accompanied by an increase in the percentage of multi-room apartments (three rooms and above) from 30 per cent in 1970 to 50 per cent in 1975. The apartments are to be equipped with all necessary technical features. Provision has been made in the new plans to incorporate such improvements as better sound insulation, tighter jointing, the use of new construction materials and more modern technical and sanitary equipment.

The types of apartments found in residential buildings are normally determined by local demographic considerations.

The most commonly encountered house type is the multi-storey multi-sectional house with apartments of from one to five rooms. For single persons and some two-member families special buildings with one-room apartments are being constructed; and hostels are being provided for the temporary lodging of young people. Special-purpose buildings to be used as rest homes for the elderly are also being built.

In the southern regions of the country, where through ventilation is required for every room, in addition to sectional-type structures gallery and gallery-section buildings are also being erected.

The number of storeys for apartment houses in cities and urban-type communities is determined following a careful technical and economic study taking into account natural and climatic factors, urban development considerations, the material and technical base and the demographic characteristics of the construction area.

During the current five-year period it is planned to accelerate the construction of multi-storey buildings (9 storeys and more), which will make it possible not only to achieve a more attractive architectural style, but also to enhance the comfort of the occupants, since all high-rise buildings are to be equipped with elevators and garbage-disposal systems.

Intensified high-rise construction is planned for:

- The largest cities with populations of one million inhabitants and more;

- Cities in which vacant space is extremely limited or altogether non-existant;

- Territories presenting difficult geological engineering problems;

- In urban renewal areas of cities with major programmes for the replacement of existing housing.

By 1975, it is estimated that buildings of nine storeys or more will account for some 25 per cent of the total volume of State and co-operative construction activity. Four-storey buildings have been primarily planned for hot regions and also for regions characterized by difficult geological (seismic) conditions. The principal building types for rural locations are to be well-designed 1- and 2-storey structures using locally available building materials. All these steps, plus a number of other specific measures, will result, during the current five-year period, in a substantial improvement in the qualitative level of apartment design and housing construction as a whole.

At a time when the number and range of standard plan series for apartment and public buildings is increasing, the USSR is focussing special attention on methods to improve the modular co-ordination system for building element dimensions so as to provide a means, despite the great variety of plan alternatives, to standardize the dimensions of industrial building items.

Maximum standardization is to be required for products having no bearing on the functionality or architectural style of the buildings. With regard to such items as large wall panels, roofing, windows, doors and the like, these are to be available in fairly extensive modular-dimension series to permit considerable latitude in building design on the basis of the selected modular pattern. Provision is to be made for various types of entrances, balconies, loggias and the like, the structural elements for which, while not standardized, are nevertheless to be co-ordinated. Standardization takes in not only building components, but also elements of form and outer trim.

The following are the basic documents guiding the unification and standardization of the elements and components of residential and public buildings in the USSR:

- Construction Norms and Regulations;
- State standards and inter-Republic technical specifications for structural members and building items;
- Rules governing layout elements, overall dimensions and equipment arrangement;
- Listings and catalogues of standard industrial items.

The modular system norms in force in the Soviet Union - which were adopted in 1954 and revised in 1962 - establish the size of the basic module at M = 10 cm, as well as the size of the larger modules 3M, 6M, 12M, 14M, 30M and 60M and of the fractional modules 1/2M, 1/5M and below. In addition, the linear limits to the use of each module, the rules governing the arrangement of the axes of the modules and their co-ordination with structural elements have been formulated and the nominal and constructional dimensions of structural items have been established.

To allow for greater flexibility and variety in layouts, the new plan series for apartment buildings with load-bearing walls of reinforced concrete panels, brick and blocks permit the selection at will of major support structures longitudinally and transversely spaced at intervals which are multiples of the oversize module 3M = 30 providing this spacing does not exceed 3.6 m (or, where necessary, 7.2 m).

The larger 15M module is employed in the case of frame-and-panel-type dwelling structures where relatively great latitude is afforded in the arrangement of the partitions.

In public buildings of frame-panel design the size of the column arrangement module is even greater. Here, longitudinal and transverse spacing of 3.6, 9 and 12 (multiples of 60M and 30M) is employed, and, where required, spacing of 4.5 and 7.5 (multiples of 15M). For hall bays the modules used are 12, 15, 18, 24 and 30M.

The height of a storey from floor to floor is set at 2.8 metres for residential houses (in some cases 3 metres) and at 3.3 metres and above for public buildings (multiples of 6M).

Factory-produced items for residential and public buildings designed according to different structural systems are selected on the basis of approved catalogues, which since 1968 have been governed by a common range or selection of products. This selection establishes systematic series of item sizes, thereby ensuring that the items can be used in combination. It is referred to whenever buildings of different structural type are erected and includes a number of interchangeable variants. For example, the selection contains series of outer-wall panels which correspond to the following alternative facade configurations:

- Single-row storey-by-storey cutting for one or two rooms, or horizontal strip cutting for mould-cast panelling;

- Horizontal or vertical strip cutting for panels assembled from sheet material on the frame;

- Various cutting configurations for panels stamped from aluminium, synthetic and other materials.

In the USSR the most widely encountered residential building is the frameless large-panel variety with closely spaced transverse load-bearing walls (2.4 and 3.6 m) and room-sized interflooring. The multi-layer external panels consist of two reinforced concrete slabs (the thickness of the outer being 4-5 cm, that of the inner -10 cm), between which is sandwiched the heat insulation. Also employed for the outer walls are single-layered panels of light concrete with a number of light-weight aggregate fillers. Internal load-bearing transverse walls are designed of flat reinforced concrete panels measuring 12, 14 and 16 cm in thickness. Light-weight concrete is gaining ever wider acceptance for the construction of large-panel houses.

Such large-panel buildings with wide spacing between the transverse support walls -7.2 m) offer a number of layout advantages over buildings with narrower spacing; on the other hand, because of the heavier weight of the structural elements the wide spacing makes it difficult to use room-size floor panelling.

Inasmuch as frame-panel houses are less economic than frameless large-panel buildings with transverse load-bearing walls, the use of frame and combined designs is mainly advisable in regions distinguished by difficult engineering and geological conditions. For buildings of 16 storeys and more, two dimensional (flat) and three-dimensional (modular) frame designs are employed. The three-dimensional (modular) frame construction permits greater standardization of collar beam and frame joint design than the two-dimensional approach, and, consequently, greater simplicity in manufacture and assembly of these elements.

A technique of great promise is the individual method of dwelling house construction using cast-in-situ reinforced concrete. The use of sliding adjustable centring yields a substantial economic effect since it permits a 30-35 per cent reduction in the consumption of metal (in comparison with large-panel buildings).

At the present time the Soviet Union is making increasingly extensive use of the space-block concept of prefabricated home-building based on the factory availability of completely finished "block-rooms" and large building sections. With this method of construction, 75-80 per cent of all labour outlays for the erection of the building are shifted to the plant, making it possible to increase labour productivity and shorten building schedules. Under Soviet conditions the space-block prefabricated construction technique is especially attractive in regions where the winters are long, and also in areas where there is a shortage of construction workers.

During the current five-year period the Soviet Union will build 27 plants for space-block prefabricated housing with a total capacity of over 2,500,000 square metres of floorspace.

Industrial prefabricated home-building involves certain specific features which set it off from other sectors of the building industry. Here, just as in other industrial branches exposed to frequent changes in individual characteristics of the product line, there is the problem of flexibility in technology and production management - one of the key economic problems on the path towards technical progress in house-building and in construction for cultural and community needs.

By turning out a sufficiently broad and variable line of building items it will be possible to construct a variety of buildings in different sequences and in different combinations as well as to modify the building plans as they are improved and periodically (every 4 or 5 years) to change the series. Current and periodic changes must not be reflected - even over relatively short time periods - in the enterprises' production capability (which should not change by more than 5-10 per cent) and must not require large investments of metal or money.

In the course of its actual production activity a house-building enterprise is confronted with three problems which it must solve:

1. The periodic transition, every 3 to 5 years, from one series of industrially produced buildings to another; this is primarily associated with periodic changes in social conditions and housing standards and also with improved architectural designs for better houses and more comfortable apartments.

2. Changes in the schedule of buildings to be erected at a given time (within the limits of the overall listing of buildings comprising a series) in accordance with the building programme and the sequence of construction.

3. Changes in the schedule of fittings, etc. produced to tie in with the production of structural elements and ensure that full sets are available as required. This problem, which is one of responsive production planning, must be solved on a day-to-day basis.

Analysis of the architectural and structural approaches used at the production and in the design of large-panel industrially produced buildings clearly reveals three distinct factors which are responsible for the diversity of these structures:

1. Differences in the geometric dimensions of the basic structural elements of the buildings (internal walls, flooring, external walls), which determine the volumetric and spatial arrangement of the building and the pattern of its facades.

2. The composition and diversity of architectural details (entrances, balconies, decorative features and the like), which contribute to a richer architectural style in individual houses or building groups.

3. The appearance and diversity of the finishing (colour, texture) of outer walls and architectural details.

This kind of classification is related to the different frequency with which the various parameters enumerated are changed.

The most difficult problem is that of achieving diversity, and the possibility of change, in the geometric dimensions of the buildings' major structural elements, inasmuch as this is linked to basic technological equipment.

Architectural details are used sparingly in modern buildings, and for this reason their manufacture and - if required - even frequent changes in their dimensions have no effect on the economic indicators of an enterprise's operation.

Modifications to the colour and facing of parts - principally outer walls - can be handled in a technologically simpler manner, and, provided the necessary materials are available, require only the existence of properly equipped finishing stations. In the future, through the use of long-lasting dyes, it will be possible to employ the mechanized paint application technology now in use in other branches of industry (e.g., light industry and the automotive industry).

Modifications to the geometry and configuration of the reinforced concrete components of industrially produced buildings involve only changes to the geometry of the mould cavity. The filling of this cavity during the moulding process is a well-developed process and one that can be satisfactorily carried out by multi-purpose machines.

On the basis of a study of the work experience of foreign and Soviet building plants and enterprises using precast reinforced concrete, the Central Scientific Research and Planning Institute for Standard and Experimental Planning of Housing (TsNIIEPzhilishcha) has developed principles for a flexible technology in the production of a wide range of parts at a single house-building enterprise to provide the possibility of changing this product line without stopping production and without the investment of material resources of any consequence.

The possibility of manufacturing this extensive and periodically revised range of components at a single building enterprise is supported by a whole set of measures based on the maximum unification and standardization of all production and output parameters unrelated to the functional purposes and architectural style of the buildings, as well as by the achievement of maximum flexibility in the architecturally related parameters.

Measures aimed at securing an effective production base include the following steps:

1. Interchangeability of moulds, as required, on assembly lines in accordance with changing needs for specific items, without the need to recalibrate machinery in operation or to vary the timing of the line.

2. A higher mould utilization factor through the use of universal designs to make possible the adaptation of moulds, by resetting, for the production of several types of items.

3. The establishment of production organization patterns with mould resetting stations and make-up stations for complex articles grouped into special sections operating at a slower rhythm not directly co-ordinated with the rhythm of the basic production line, thereby ensuring production cycles of constant output, the possibility of resetting moulds and making-up moulds for complex items, and favourable conditions for rapid replacement of moulds on production lines.

4. The application of technological procedures to retain a preset production pace despite any list changes or modifications to the size, texture or finishing of articles and the like.

5. The creation of a system of production management with automatic output control based on the use of computerization techniques.

While opening up attractive opportunities for architects, a flexible house-building technology also imposes a number of constraints in the area of architectural planning. A house-building plant operating on the basis of a flexible technology has a certain limit to its capabilities and is organized according to certain rules. An understanding of the technical limitations of the plant is the first condition to be met when planning the range of industrially produced building items to be manufactured at a given enterprise.

Compliance with this condition is the ultimate guarantee that a plant will be able to undertake the production of a new house series and that its plans will be marked by that kind of rational technological effectiveness which is in turn the key to low-cost production. This is why the development of plans for industrial buildings is a task requiring the integrated solution of architectural, structural and technological problems.

All these stages call for the joint efforts of architects, designers and technologists, this being a necessary precondition for the maximum exploitation of production capabilities and the creation of cost-effective and high-quality standard plan series for large-panel buildings. The principles of flexible technology underly the fully prefabricated house-building base now being established and modernized in the Soviet Union.

However, improvements in the quality of housing - better sound insulation, equipment, finishing and other measures - result in a general increase in the cost of housing construction. For the prefabricated house-building enterprises the effect of these planning changes is a two-fold increase in the volume of processed reinforced concrete computed in terms of dwelling floorspace.

The areas in which construction costs can be reduced lie primarily in the sphere of production and preparation of building materials, especially concrete and reinforced concrete.

Of enormous importance, therefore, are methods of production intensification and technology improvement aimed at lower plant labour expenditures and at the use of less metal in equipment and at production sites. The proposals which have already been put forward and are now being formulated with regard to production intensification fall into two categories:

- Proposals not requiring radical restructuring of the adopted technology and organization of production;

- Proposals entailing changes in the technology and organization of plant product

The first group includes organizational measures involving improvements in raw material quality, more effective distribution of production capacities and the like.

Also included here are such proposals as the lowering of the temper strength of house-building plant output and the use of preheated concrete mixes.

Radical changes in technology involve the mastery of new technological procedures and the replacement of equipment. The research and development efforts being made by a number of organizations are aimed at the further mechanization of labour-intensive moulding processes through the use of moderately hard mixtures, which will make it possible to reduce considerably the hardening times of concrete articles and in this way to achieve better technical and economic production line performance.

Under this heading we find methods for converting palletization production to an assembly-line footing, methods for the moulding of sanitary engineering facilities and three-dimensional units using moderately hard mixtures, vacuum and press-vacuum methods, vibration-free concrete mixture compacting methods and many other suggestions. All these techniques are at different stages of development, but most of them have already been industrially tested and there is every reason to believe that they will soon find their way into actual production practice.

Analysis shows that the integrated application of these techniques at a single enterprise will permit a 20-25 per cent decrease in capital investments for the construction of the plant, a 10 per cent decrease in the cost of the plant's production and a 20 per cent decrease in construction-related labour outlays.

In further developing its housing programme, the aim of the USSR is to upgrade qualitative building standards, make labour-saving devices increasingly available in the home and provide tenants with rational access to public services. The construction of houses and of communal cultural facilities is to be increasingly based on up-to-date, individual methods for the production of materials and structural elements to enable massive building projects to be carried out at the least possible cost.

The major house-building trend will continue to be the total development of residential regions and micro-regions with an extensive network of public community-service and cultural buildings.

With respect to the height of housing projects, there is to be a shift towards a larger proportion of multi-storey buildings (9 storeys and above) - the total proportion of which will in due course be more than treble - and also of 3- and 4-storey buildings. This is to be accompanied by a sharp reduction in the construction on uneconomic 5-storey and 1- and 2-storey houses.

The large-panel system with narrow and wide spacing between transverse load-bearing walls (from 2.4 to 7.2 m) is being adopted as the basic structural system for use in dwelling houses.

Heavy concrete will continue to be used as the principal material for the load-bearing structural members. It is intended to make extensive use of light-weight concrete and suspended panelling fabricated from effective materials.

In the future, the greater height of dwelling houses and the need to provide greater latitude in the selection of layouts will require the introduction of the frame-panel structural design based on the use of a metal support framework and light combined panelling. The varying ruggedness of the frame elements and dwelling modules is in keeping with the need for variable apartment layouts and will ensure the required freedom of choice for each family in the selection of an apartment type.

Along with the large-panel construction method there is to be further development of the totally prefabricated space-block house-building concept based on the factory delivery of completely finished apartment units and larger building sections. The space-block house-building technique is to be extensively used mainly in regions where the winters are long and in areas where there is a shortage of construction workers.

In rural housing construction the average height of buildings will be increased with the introduction of houses having two or - in suburbs and to some extent in the central areas of villages - three to four storeys. Single-storey construction projects are to be developed in the outskirts of residential zones. Two-storey construction will also become common, resulting in 15-20 per cent lower building costs because of savings in engineering services and conveniences. Twin-level solid-construction apartment houses offer particularly rational features in that they can be compactly built and can additionally be designed to include small garden areas.

According to projections for the period 1990-2000, the outlook is for panel-type space-block and frame-panel structures with relatively wide spacing between vertical support elements (approximately 8.4 - 9.6 - 12 m).

Bathroom, kitchen and passage-way units will be designed in the form of fully equipped three-dimensional support blocks, while it is expected that the vertical shell structure - partitions and dismountable outer walls - will be produced from effective light-weight materials. In addition to high-strength concrete and metal, new materials possessing the required properties will make their appearance for use in support structures.

The basis of scientific and technical progress in the construction area continues to be industrialization, a concept which includes such aspects as rationally organized planning activities, the mechanized and automated production of building elements, items and components at specialized enterprises, and the extensive mechanization of construction and assembly operations at the building site.

The solution of the housing problem and the satisfaction of the public's varied requirements in this field call for broad, scientifically based planning. In addition to the basic social-demographic, material-technical and other conditions and factors affecting housing construction, such planning must also take into account the economic possibilities of the State and probable changes in technical and economic housing indicators. The process of improving housing quality standards and bringing them into line with the individualized requirements of the public will entail radically different approaches and more complex planning than has so far been necessary.

Certain planners tend to reduce the task of housing development merely to a matter of planning new construction, which they regard as the sole effective means of improving the population's living conditions. The fact is, however, that society's housing needs are met by the entire aggregate of existing residential buildings, by all the dwelling floorspace available at a given moment of time. It is important, therefore, when discussing the development of housing facilities, to keep in mind the preservation and upgrading of existing housing assets.

This approach to the basis of housing construction raises complex problems relating to the appropriate "mix" of housing facilities, the determination of rational proportions in housing renewal, loss and construction, and also certain little studied questions of the effective redistribution of housing.

THE INDUSTRIALIZATION OF CONSTRUCTION AND THE EXPANSION OF THE CONSTRUCTION MACHINE AND TRANSPORT POOL

The problem of industrializing construction is solved by putting the production of structural elements and building components on a factory basis. The result is the emergence of three spheres in building production: (1) an industrial base; (2) a complex of transport facilities for the delivery of larger structural elements and building components from the plants to the construction sites; and (3) a complex of mechanical facilities and auxiliary equipment for the execution of foundation operations and the assembly of buildings and structures at the construction site.

Improved efficiency depends on the establishment of proper ratios between these spheres of building construction, and also on the soundness with which their future development is projected.

With the increasing ability of transport facilities to haul cargoes of greater weight and size and the decreasing cost of freight handling, it is becoming possible to shift a number of operations involving the production and large-scale assembly of structural elements and equipment from the construction site to the plant. As more and better transport facilities become available, the future outlook is for deliverability of large building blocks and major structural elements directly to the point at which they are to be assembled. As a result, the level of industrialization in the building sector is to some extent a function of available transportation facilities.

The development of the construction equipment pool depends, in turn, on the degree of prefabrication, the technological aspects of construction operations and the size and layout of the structures being built.

The extent to which it will be possible to eliminate manual labour and improve the productivity of the construction work force depends on the rational development and utilization of the construction machine pool.

Projections regarding the construction machine pool must be based on forecast volumes of construction and assembly activities and on predictions of their branch-by-branch and territorial distribution. Based on the physical volume of the work and the yearly output of the equipment, a determination is made of the types and characteristics of the machinery required. This is accompanied by a study of the economic effect in terms of minimum expenditures per unit of work, to be gained from the use of interchangeable machines and the establishment of the optimal - that is, the most economically rational - breakdown of the equipment by standard size.

The principal future trends in the development of construction mechanization facilities include the design of new and effective types of building machinery based on the establishment of a single set of characteristics along with a limited range of standard dimensions for the basic machines; standardization of the components and subsystems of construction machines and equipment used at building sites; the design of original mechanization techniques and systems for the replacement of manual labour in building and assembly operations (especially heavy and hazardous manual labour); the creation of new machinery and component systems to make possible the over-all mechanization of major building operations and also for use in allied construction areas (e.g. pipeline construction, railroad building and highway construction); and the design of specially climatized mechanization facilities for northern and southern conditions.

Projections regarding the construction machinery pool have revealed the economic advisability of substantial increases in the over-all percentage of heavy-duty machines (by a factor of roughly 2.5 to 3), the production of a larger quantity and wider range of machinery to perform operations currently performed by hand, and the design and introduction of universal multi-purpose machinery with interchangeable component systems as well as mechanized tools and new facilities for minor mechanization.

Thus, the short-term outlook is for an increase in the proportion of excavators with a scoop capacity of 0.5-0.6 m^3, this to be accompanied by a reduction in the proportion of excavators with a scoop capacity of 0.15 m^3. The proportion of 220-HP bulldozers also needs to be increased.

At the present time, trucking is the predominant mode of transport, responsible for the delivery of between 80 and 85 per cent of building cargoes to construction sites. Future planning, however, will place far greater emphasis on air freight, particularly in the remote and poorly accessible regions of the North, Western and Eastern Siberia and the Far East.

Economic projections of the use of various transportation modes for construction purposes must include studies of their long-term technical and economic evolution and cost analyses relating to the delivery of cargoes from the industrial enterprises of the construction base to the building locations. In this same context, allowance must be made for the expenditures to be incurred in the assembly and dismantling of enlarged structural elements and equipment units (at the plants and at the construction sites), the trans-shipment of freight, warehousing operations and other measures as encountered under a variety of circumstances.

The future would appear to offer extensive opportunities for new forms of transportation in the construction field.

In the case of air transport, what is required is that the aircraft used should be capable of taking off and landing on the simplest, unequipped air-strips, and of hauling cargoes of considerable size and weight. With the series production of the giant AN-22 ("Antei") aircraft, a tool will be available for the solution of this difficult problem. Once the AN-22 has gone into large-scale production, it will become possible to rely extensively on air cargo service and to organize the delivery of industrially produced structural elements from central territorial and regional supply centres to remote localities in the undeveloped northern areas.

The steps to be taken to upgrade the efficiency of truck transport must necessarily include a higher standard of technical preparedness of the vehicles, an improved coefficient of utilization per journey, and longer mean-daily periods of operation.

As the Soviet Union's economy continues to expand and more and more modern construction machines and road transport vehicles are produced, the question arises of largely discontinuing major repairs for certain types of equipment in cases where such repairs are no longer worth-while and of replacing worn machinery with new.

Greater efficiency on the part of the technical maintenance and repair system depends, above all, on the incorporation in construction machinery and automotive vehicles of the kind of design improvements which will greatly reduce outlays in labour and material by the use of such techniques as automatic lubrication, component and part standardization and the like. Components and sub-systems in new equipment must be arranged so as to require far less time for maintenance and replacement. The use, for example, of a hydraulic drive system rather than a mechanical transmission not only makes it possible to reduce the size and weight of the machine, but also the number of lubrication points (in the case of excavators, to as few as 30 instead of the 124 to 200 required for equipment with mechanical transmissions).

The socio-economic effect to be gained through the implementation of these new trends in the development of mechanization and transport facilities consists primarily in the achievement of a higher degree of industrialization in the construction industry and an increase in the productivity of construction workers. The elimination of manual operations, and, especially of difficult and dangerous tasks, is a factor of major importance. The effect here will be to promote the upgrading of worker skills, to reduce manpower wastage and to eliminate discrepancies in working conditions at construction sites and in industrial plants.

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An effort has been made in this report to consider the development prospects in the major areas of the construction industry in the Soviet Union.

The information presented in the preceding pages was drawn from a study of existing building practices, from data provided by scientific and drafting organizations and from agencies charged with central planning, as well as from projections of national economic growth.

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