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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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GENERAL OUTLINES OF THE DEVELOPMENT OF THE INDUSTRIAL BUILDING IN POLAND [1]

by

B.K. Koy *

* Architect, Warsaw, Poland.

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SUMMARY

In consequence of the destroyed technical and economic structure of the country, as result of Word War II, the Polish building begun to develop in far worse conditions than those of many developing countries.

The following periods of the progressive industrialization of the building methods can be specified:

up to 1950
from 1951 to 1960
from 1961 to 1970
after 1970.

Methods characteristic for these periods are described in the report. The building industrialization is based on the all-country standardization (typification). The mass production of typic components is enabling the increase of the productivity of the workers. The manpower decreasing by 5 % yearly can perform output increasing by 10 % yearly. Now, for one worker employed by the industrial building there are 27 employed by all branches of industry. In 60 years the respective proportion became 1:11.

The building industrialization is followed by the change of materials and construction concept. Walls and roofs made from hollow blocks applied before 1950 are replaced, at first by shell structures made on slide scaffolding and then by prestressed concrete plates and girders, and finally up to the present time, by profiled thin metal sheets galvanized and covered by plastics.

Previously concrete plates were generally applied for cladding of steel skeleton. Now, thin profiled sheets are used for cladding both steel and concrete skeleton. By this means the dead weight of walls and roofs decreased 10 times, the labor outlay for assembly works five times and engagement of transport 15 times.

Introduction of light structures made from thin sheets generated the problem of durability of the building components and reliability during all exploitation period.

The economically justified life time of industrial buildings is limited to 40 years. After this period the site built over with an old building is of lesser value than the same area without any building. During this period the building components should not be repaired nor replaced but only maintained by cleaning.

Erecting buildings of high exploitation reliability, we save the costs of repairs and decrease the number of workers employed. By the year 1980 every fourth qualified worker was employed at repair works.

The essential changes of the methods of serial production of building components can be observed. The smooth linear steel or concrete components as well as plate components are produced on flow production lines of great output. In order to ensure the ready market for the said components typification obligatory all over the country is introduced.

Standard plans of typical industrial buildings are prepared by governmental authorized Institut "BISTYP" by means of computers which carry out not only calculations but also automatically, drawings.

On the building materials market appeared very efficient materials for thermal insulation made of mineral fibres and foamed plastics. This creates the tendency to increase the insulation capacity of walls and roofs, thus the heating costs are reduced.

Experiences of the Polish industrial building show that in spite of different requirements and needs of various industry branches, one-story as well as multi-story buildings for production and storage can be constructed with typic serial produced components. By the same, the question, whether the building can become a modern industry got a fabourable solution.

Development of the serial production of typic components requires a reasonable programming based on the consistent system of needs analysis and marketing. In Poland, every designor of industrial building gets orientation from the Marketing Center which transfers to the factories of components information about the requirements of components for the whole country and for the determined time.

Being eager to carry out the increasing tasks under terms of increasing lack of workers, the industrial building has to base its development on the serial production of typic components. This production is programming by the National Center according to the actual demand.

Under the above conditions the industrial building can become a modern industry managed in a rational way.

[illegible]

[illegible]

[illegible] country, with the [illegible] very well [illegible] grew the iron [illegible] steel industry. [illegible] first years of [illegible] development.

[illegible] products of inorganic chemistry [illegible] The light industry was limited to the textile and leather branches. The engineering, shipbuilding and many other industries were also not enough developed.

During the Second World War the Polish industry was destroyed. About 70 % of industrial buildings were completely devastated and the remaining ones required major repairs. There lacked building materials, means of transport, qualified workers most of all architects and engineers.

The reconstruction of destroyed buildings was carried out by means of materials taken from rubble. The setting materials lime and small quantities of cement were applied. The plants were organized to produce hollow blocks by hand.

THE FIRST INDUSTRIALIZATION PERIOD OF BUILDING ENGINEERING 1951 – 1960

The described methods could not be applied for a long time. We grew short of materials taken from destroyed houses as well as of workers who, as a rule, gave up the building profession and passed to the work in new organized factories.

Meantime, the tasks of building engineering increased by 15–25 % yearly. The initiative was taken in changing the economic structure of Poland from mainly agricultural into industrial and agricultural. The basic building materials were, within this period, cement furnished by reconstructed cement plants, natural aggregate, sand, gravel. The plasticity of the reinforcing steel furnished by the metallurgy industry was limited to 2500 kg/cm^2. Shaped steel was received by the building engineering in small quantities only, for

the majority of this production was furnished to the industry manufacturing machines and means of transport. On this material basis developed within this period beam and plate ferro-concrete constructions applied for halls with the pole spacing to 12 m and for greater spacings shell structures, cylindrical, conoidal and parabolic ones, with spacing up to 30 m.

As the halls with spacing 24-30 m were very much required and there was a deficiency of steel profiles, the shell structures became the most popular.

The rapid development of the elasticity theory and of the related shall theory followed. The more difficult tasks were dissolved through the model testing of constructions on a small scale.

For measurement purposes electro-resitance strain gauges were used.

From this period of time originated some buildings which entered into the history of industrial architecture. Having such a universal material as the concrete laid in situ at one's disposal, architects and structural engineers competed in designs of beautiful, new forms of hall buildings with roofs equipped with overhead shade skylights. The fault of the shell structures which stopped their further development was their great demand of work time amounting up to 12 working hours, 1 m2 of the hall surface. In order to decrease the working time, the outrigger scaffolds (combines) were used. In order to speed up the hardening of concrete, boardings were heated by steam.

By the end of the fifties new views connected with existing problems crystalized and led finally to the modification of the methods of design and execution.

The most important of these problems were:

- inefficiency of building enterprises needing a lot of qualified workers, carpenters, steel fixers, concreters, as well as deficiency of wood for boardings and scaffolds.
- lack of interest on the side of investors accepting with bad grace designs of beautiful form but of difficult construction, the final costs of which could not be foreseen in advance.
- lack of possibilities to undersling installations and cranes to the shell roofs.

[illegible] factories, [illegible] buildings
[illegible] stimulation

[illegible] designers [illegible] single-handed
building [illegible] principles [illegible] complicated
structure.

[illegible] the construction of factory halls using [illegible] standard designs. The standard designs elaborated by the authorized institute "BISTYP" did not require to be accepted every time by the local building authorities. It was to be underlined that at the beginning of the introduced typification the main question was to save the time of designers whose limited number not [illegible] the development of the civil engineering. It was difficult, of course, to typify the whole factory halls. The typified hall segments were the basis on which to operate.

There were nine of them. With these segments a hall of any kind of dimensions, but rectangular only, could be assembled. If the halls were of figure of letters "T", "U" or "L", then the number of segments would be increased.

The typification based on segments was not always satisfactory. The new industrial halls are often constructed in built-up areas. They lie close to the already existing buildings. Then it is necessary to apply individual solutions and to modify the typical projects. The use of typification based on segments did not prove to be very practical. This method was criticized many time in that it did not serve designer work, introduced monotony of solutions, and did not give possibilities of the use of local, easy accessible materials. It was difficult to adjust the standard segments to the individual requirements of different industries, for example the textile industry needed introduction of technological floors, the chemical industry required higher resistance against corrosion and so on.

The segment system was especially strongly criticized by the producers of the concrete elements. In Poland those producers are associated in a national trust. By the end of 1960 this industry constructed new plants of the concrete components.

The type, quantity and their dimensions increased quickly. It was necessary to carry out great quantities of shapes. The concrete placing

was made by hand and, though the time of 1 m³ of wall-making decreased to four working hours, the need for investments in the concrete industry increased considerably. The concrete plants could not be submitted to the mechanization and automatization. They were, in fact, manufactured only where the preparation process and transport of the concrete mass was mechanized.

THE SECOND INDUSTRIALIZATION PERIOD OF BUILDING ENGINEERING, 1961 - 1970

The always increasing need of production buildings led to the necessary modernization of industry, working for building engineering. It is to be mentioned that in the Sixties, the limitation of the use of shaped steel was still prevalent, thus 80 % of industrial buildings were constructed with concrete.

On a large scale elements made of concrete tensioned with steel cables and strings were introduced, the steel plasticity amounting to 1500 kg/cm2. For new, modernized concrete plants new types of compressed girders were elaborated at a span of 12-30 m, made of concrete of 500 kg/cm2 strength.

Most often girders of I - section and roof slates of 6 and 12 m span were produced.

In order to adjust elements to one another, the module system based on the module M = 30 cm was introduced.

The National catalogue of Building Engineering was elaborated which gave specifications of the produced concrete and, partially, steel elements. The designer stopped working with the standard segments and could, using elements of different dimensions, design industrial buildings of any form. It was so called "open" typification.

A very new idea was the introduction of "construction systems". Under this term it is to be understood the complexity of organization and technological solutions, comprising sets of unified construction elements, finishing of the buildings, their equipment with installation and with machines, necessary for transport and assembly. These construction systems became the higher degree of typification, enabling the industrialization of the building engineering. The major part of the work was passed on to the factories of concrete elements and work in building was limited to the assembly of finished elements, furnished in sets with such elements as windows, doors and skylights. The newly created specialized enterprises delivered all

building elements according to the determined time schedule.

The application of the system was [illegible] in the Polish building industry. It made possible the decrease of staff (employment in the building industry [illegible] by [illegible] %) to carry out tasks increasing by [illegible] yearly.

In introducing the systems, we did not realize, however, how complicated and far-reaching the activities necessary to carry out the whole of the building [illegible]. Industrial building engineering is not the construction of buildings only, but also of building machines, habitat protection, heat sources, energy, transport, roads, water supply and so on. Table no. 1 shows the shortened scheme of the building "engineering system". It shows the whole extension and range of the problem.

Even in a country with central control of economical activities where means exist to force investors to construct buildings comprised by the system, it proved impossible to unify the whole industrial building. The necessity of designing individual halls became less, but was not completely eliminated. Nevertheless, a high degree of typification was reached. Still in 1970, the value of standard elements produced [illegible] production, reached 70 % of the total value of industrial buildings constructed that year. The development of industry building elements made possible the increase of the surface of constructed factories by 20 % yearly. System building engineering became the basis for the high achievement rate of the industrial production reached in 1970.

DEVELOPMENT CONCEPTIONS OF THE INDUSTRIAL BUILDING ENGINEERING AFTER 1970

At present in Poland, we dispose of a basic amount of production components to construct [illegible] mln m2 yearly of usable surface for one and multistorey buildings. We consequently test and register the requirements for these buildings. Information about each building planned by design offices in the whole country, specified on special forms, are passed on to the centre recording the requirements. This centre examines the balance between requirements and the production possibilities. It answers to the designer, whether he can depend on the delivery of building components in proposed terms. It often happens that after reviewing the requirements, the Centre suggests other solutions. This is, consequently, an organized marketing, ensuring on the one hand, the covering of needs, and on the other, the production continuity of components factories.

As part of the designs is not carried out, it is necessary to make corrections of the balance, on the basis of new information given this time not by the designers, but the general constructors when signing the contract.

All building components are contained in the national catalogue. Each component has a cod classification.

Buildings are planned by computer methods carrying out technical and economical calculations, assembling lists of components of designed object necessary for the designer. This is carried out by the Designing and Study Institute of the Industrial Building Engineering "PIBTYP". They also do drawings of factory halls, by automatic methods or by means of sticking on to transparent foil (leaf) of finished parts of drawings, printed on pieces of foil. These methods save 60% of designers' time and dismiss them from the routine work.

The computer systems generalized now within the Polish industrial building industry comprise one and multistorey constructions using concrete as well as steel and wood.

The concrete lineal components, e.g. columns, beams and such superficial components as plates, are produced on lines equipped with mobile forms. Compressed girders, however, are concreted on long tension (pull) lines in stationary forms.

For steel construction, plate girders compete with truss girders. The advantage of the former compensating the greater use of steel is that labour costs are less. Smooth plate girders are treated on semi-authomatic lines, carrying out the cutting into parts of required length, boring of openings, cleaning and painting.

The characteristic of new methods of producing steel and concrete components is the possibility of continuous change of components' length. It is not necessary, therefore, to keep a rigid module system. We can design halls of any span, made to measure, according to investors requirements, adjusted to the machines' size and to the installations. It decreases building costs as surface of the same is minimized.

Owing to the new production methods of components we obtain a great economy of labour. In the case of steel constructions, 10-12 working hours are needed for 1 ton of components.

The Polish steel [illegible] assortment of [illegible] 2.60 mm high and [illegible] 1.6. This assortment of [illegible] storey buildings [illegible] with a span of up to 50 m, as well as frames [illegible] floor load of 1500 kg/m2.

Industrial [illegible] is now designing multi-storey industrial buildings, the columns spaced 6 apart in one direction and 12 in the other. The building is 50 m high. According to [illegible] location of factories [illegible] residential quarters, this building will be constructed in the centre of Warsaw, surrounded by high apartment buildings.

We are now introducing a new method to distribute metallurgical products. The steel construction factories do not order profiles by their weight in tons only, but specify their exact length. Cutting of profiles with [illegible] accuracy is carried out immediately in the storerooms of the steel distributor. Cutting is made on special lines equipped with saws set at [illegible] any angle. The economy of steel reached that way amounts to [illegible]. There is no need therfore to organize cutting departments in steel construction factories, thus decreasing investment costs.

Roofs and walls of halls having the steel construction are made most frequently, of shaped steel sheets, galvanized (zink plated) and covered with plastics.

Wall claddings and roof coverings of shaped sheets are more and more appreciated. Their dead weight amounts to 1/10 of the corresponding ferro-concrete plates. Labour costs amount to 1/5 and transport means to 1/5 of the respective quantities for the ferro-concrete plates.

The mass application made of shaped sheets has provoked many discussions about their life time. No doubt that sheets are less resistant than traditional concrete facings, in spite of many efficient means to protect them against corrosion. On the other hand, while investigating the economy of an industrial building within the exploitation period, one can prove that there is an Economically Justified Life Time of the building.

After this [illegible] parts exposed to atmospheric influences and mechanical [illegible].

As a result of increasing technical development, the value of non built-up areas [illegible] after some time higher than the value of the respective obsolescent industrial buildings.

We investigate the Economically Reasonable Life Time of industrial buildings. Under Polish conditions this period is now 30-40 years, and it shows a tendency to be shortened according to the economic development of the country. As the life time of buildings is limited, we postulate an exploitation reliability test in this period. It means that during 30 - 40 years the building components should be neither repaired nor exchanged but maintained, for instance by washing.

The galvanized shaped sheets covered by plastics comply with this condition and we plan their mass application. We shall reduce that way the range of repair work on industrial buildings as well as the number of workers necessary to carry it out.

Most of the industrial buildings in Poland are old or have been reconstructed after the war with materials of bad quality by not very skilled workers. This necessitates employing about 25 % of workers employed on the construction of new factories for the reconstruction of old industrial buildings. These conditions have to be changed, especially because there are no fewer building workers. We have, therefore, to adopt other construction methods, requiring as little labour time in components factories as on building sites.

For heat-insulating material, we apply more and more frequently, fire-proof plates made of mineral wool (asbestos wool). The production of mineral fibres is developing fast in Poland and eliminates from building engineering inflammable frothered plastics. Production of plates made of mineral wool is totally based on local raw materials.

Laminated boards are also produced to serve as thermal insulation and inner decorative lining.

We can state that there is a general trend towards the projecting of "warmer" walls and roofs. According to the Polish Standards, the thermal conductivity coefficient of walls made of brick and light concrete amounts to K = 0,75 Kcal/m² Ch, but now, thanks to light insulants, value of K amounts, as a rule, to 0,4 only.

[illegible] to [illegible] cost [illegible]

[illegible] construction. This is [illegible] characteristic. [illegible] automatic [illegible].

[illegible] in Poland. [illegible] Sixties [illegible] was [illegible].

The [illegible] building [illegible] increasing, while the number of workers is [illegible]. Applying the "light" building systems, we plan further [illegible] employment. The industrialization of the building engineering [illegible], in view of running out of labour reserves, [illegible]. On the basis of [illegible] component factories, [illegible] that this is [illegible] not only for branches of building engineering, but also for the steel and iron, chemical and metal industries.

The intr[illegible] increase the productivity of factories and building sites.

The second task is economy of transport. Heavy concrete components are transported by special trailers. If the transport distance exceeds 200 km, costs of heavy components are doubled because of transport costs. Far more advantageous is the transport of components by trucks such as containers as for example shaped metal sheets are loaded.

When the distance above 200 km - transport costs amount then to 1,5 % of finished roof cost only.

The development of the industry producing building components as well as programming of production, have to be carried out according to their capacity.

It is postulated that components have to be fit for different building systems. They also have to be interchangeable. In order to be equal to this task, the National Institute "BISTYP" has been created in Poland to elaborate standard documentation for components produced by series.

The Institute cooperates immediately with the concrete, steel construction, metallurgy, chemistry and other industries.

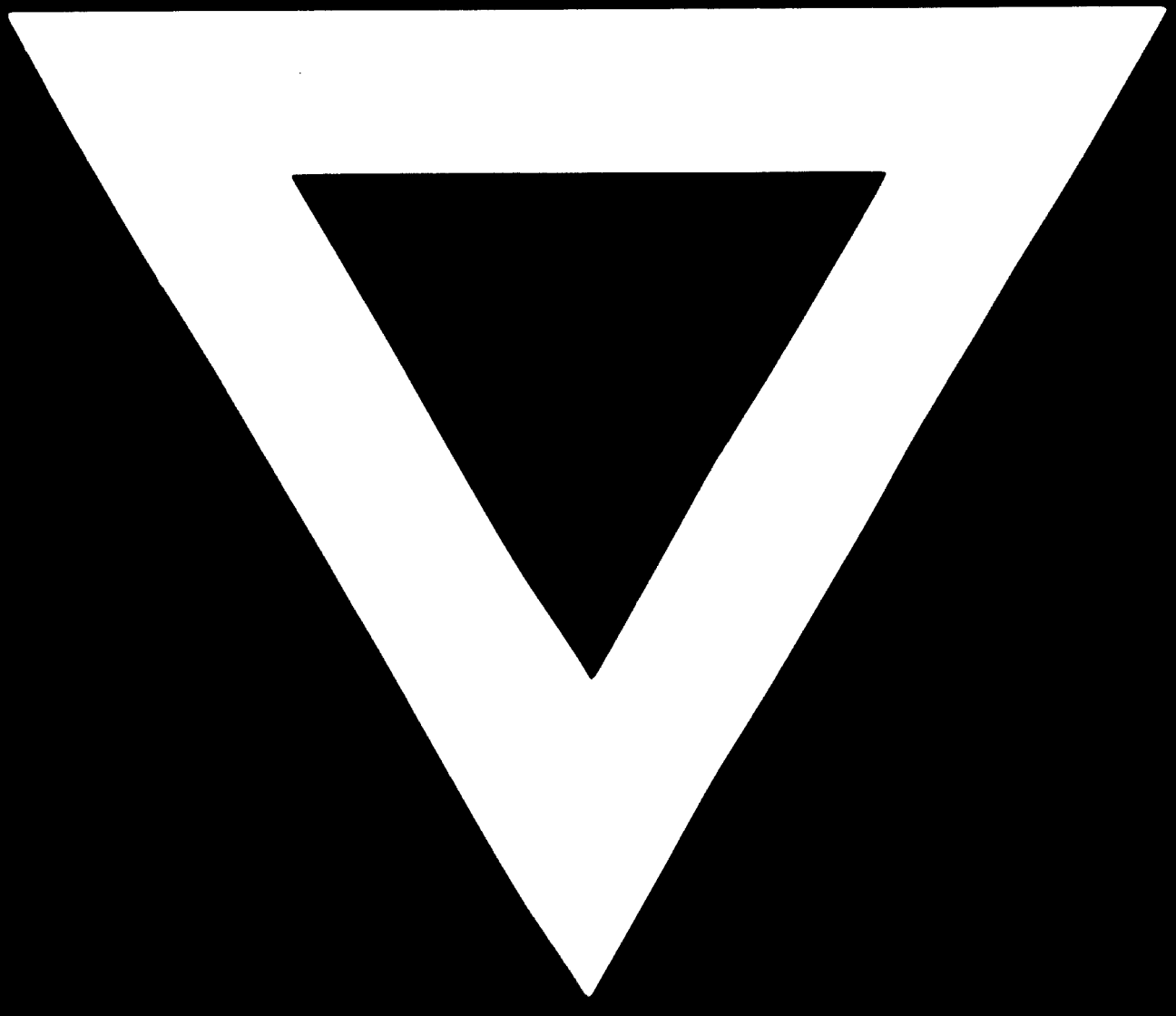
The computer system of 'ELSTYP' will be connected with computers controlling the production of the concrete industry and shaped sheets.

SUMMING UP OF POLISH EXPERIENCES

An increasing deficiency of labour for industrial construction is a rule in the conditions of a developing country. Building workers move to factories constructed by them. If the country has no possibility to import labour, it has to base its industrial building engineering on serial production of building components, composing construction and organization systems.

Production of those components should be based on standards elaborated by the chosen Projecting Institute for the region concerned.

Methods should be introduced to balance supply and demand for components, in order to distribute tasks between component factories according to their capacity.



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