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A New Method of Construction for Multi-Storied Buildings

Une nouvelle technologie pour la construction de bâtiments à plusieurs étages

Eine neue Bauweise für das Errichten mehrstöckiger Gebäude

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Andrzej Skopura, born 1928, obtained his civil engineering and doctor t.sc. degree from the Technical University in Wroclaw. For thirty five years he worked at TUW researching slabs and thin shells. He designed and realized many remarkable buildings.

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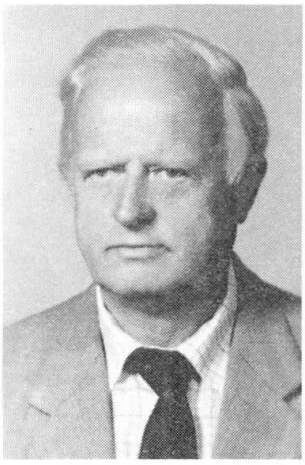

Stefan Jasman, born 1927, obtained his engineering degree and the doctor degree from the Technical University of Wroclaw, Poland. For thirty five years he was involved in research and design of reinforced and prestressed concrete.

SUMMARY
In 1983 the Building Institute of the Technical University in Wroclaw with its partner building establishments implemented a new technique of erecting multi-storied buildings. In the paper are presented the description, application area and main features of this solution.

RÉSUMÉ
En 1983, l'Institut du Bâtiment de l'École Polytechnique de Wroclaw, Pologne, en coopération avec des entreprises du bâtiment a mis au point une nouvelle technologie de la construction de bâtiments à plusieurs étages. L'article présente la description, le domaine d'application et les caractéristiques de cette solution.

ZUSAMMENFASSUNG
Im Jahre 1983 wurde am Institut für Bauwesen der Technischen Universität in Wroclaw, in Zusammenarbeit mit Baubetrieben eine neue Bauweise für das Erstellen mehrstöckiger Gebäude entwickelt. Im Beitrag werden das Anwendungsgebiet und die Charakteristiken der Bauweise beschrieben.

1. INTRODUCTION

The essence of Floors-up-Technics is known for many years. The first project, but not realized, is attributed to A.Peltzer - 1913.

After the Second World War this problem was taken up experimentally by B.Lafaille. But its prototypical realization in St.Queen was stopped because of technical difficulties.

In the fifties, two American engineers, T.Slick and T.Youtz, worked on the solution of this question. They worked out and implemented a realization method of multi-storied buildings known widely as "Lift-Slab-Technics". The "Lift-Slab" licence had been bought by many countries, in the other ones there had been elaborated some derivative methods as in FRG, GDR, Czechoslovakia, Bulgaria, Soviet Union, etc.

After the initial successes of this new building technics, a return to the traditional building methods was observed, as an effect of technical, technological and economical analyses and of psychological conditions. Such examples are know from FRG, GDR, Soviet Union etc.

2. FLOORS-UP-TECHNICS

This method of realization of multi-storied buildings has some other technical and technological characteristics than the remaining technics, though the basic idea is a common one.

As the supporting structure there are used steel columns, reinforced concrete or pretensioned concrete columns. As the auxiliary elements there may be used cores, spatial trussworks, etc. The supporting structure is mounted together with slide bars.

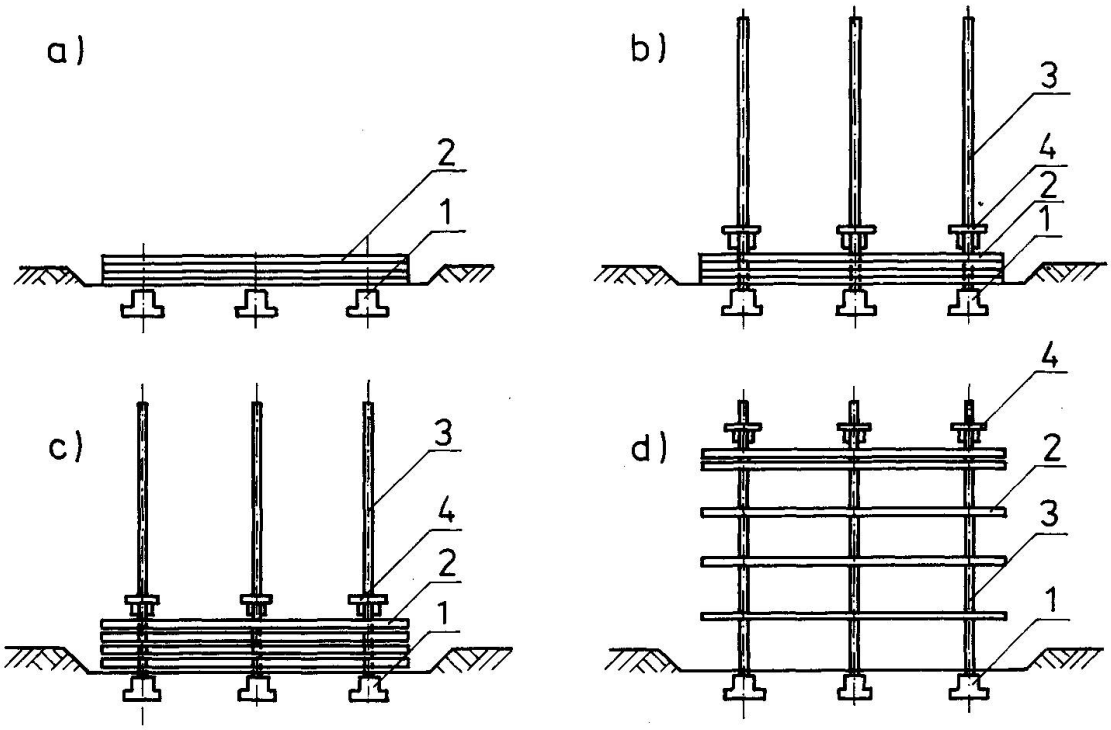

Fig.1. General realization scheme of the building:
a. execution of foundation and floors' pile
b. mounting of columns and lifting devices
c. splitting of floor plates
d. lifting and seating of floor plates

The lifting of the floors is done by means of bidirectional hydraulic jacks, climbing on slide bars connected to the supporting structure. It is a continuous process in which at one time a pile of 2-9 floors can be lifted with a speed of 1.50 - 3.00 m/h.

The floor slabs are being seated on the supporting structure one after another from underneath.

The rigidity of the construction system grows while the lifting process automatically as a result of placing the floors on supporting structure by means of wedging collars.

3. DESCRIPTION OF THE TECHNICS

A smooth concrete plain surface is to be prepared above the building foundation. It is mostly the concrete basement floor or the first floor slab. A pile of floor slabs will be concreted on this surface. After setting up the circumference, opening and columns zone shuttering, this surface is being covered with an antiadhesive agent. Then the lower and upper reinforcement in form of steel fabrics is located as well as the filling elements in form of hollow blocks or lightweight concrete ones. Concreting of floors is to be done most conveniently by means of conrete pumps. The consolidation of fresh concrete may be done by immersion vibrators, vibrating frames or by the Fremix method. The concreting process of the floors repeats cyclically.

The mounting of the columns with the slide bars may be performed before concreting of the floors pile. But because of the slide bars rotation, it is more advantageous to do it after floor concreting.

The lifting operation of the floor pile is carried out after installation of a centrally controlled set of hydraulic jacks. It can be divided into three stages:

- Splitting of the floor slabs

  At this stage, the floor slabs are being individually suspended on jacks beginning from the upper one. A gap arises between the floor slabs with a breadth equal to one step of the jacks, that means about 100 mm.

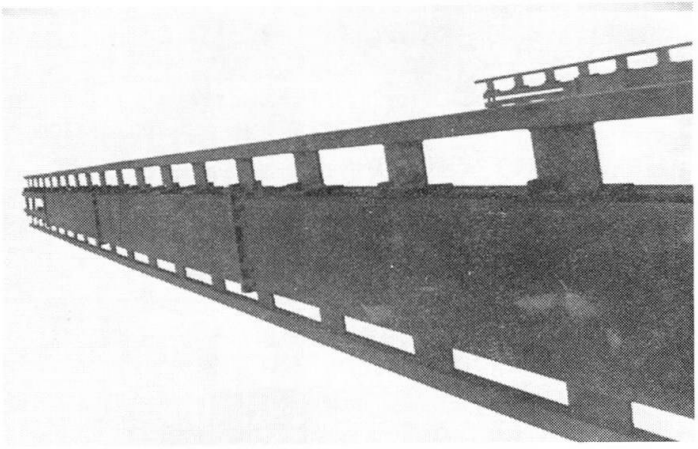

Fig.2. Steel column with slide bars and bearing collars

- Lifting of the floor slabs

  The centrally controlled set of hydraulic jacks steps on the sliding bars and lifts the whole pile of floor plates.

- Seating of a floor slab on the supporting structure

  After the pile of the floor slabs had come up to an indicated level and the wedging collars had been set up on the proper bearing collars of the columns, the floor slabs pile is lowered until the lower floor slab gets the perfect support on the supporting structure.

After removal of the hangers of this floor slab the further lifting operation goes on.

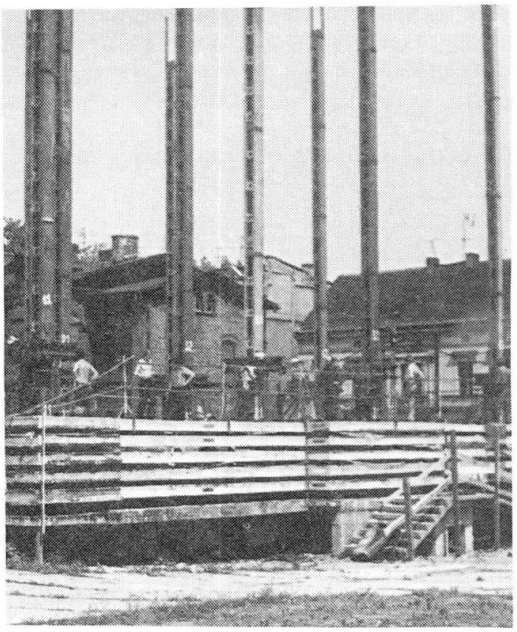

Fig.3. Splitting of floor plates of prototypical building (1983)

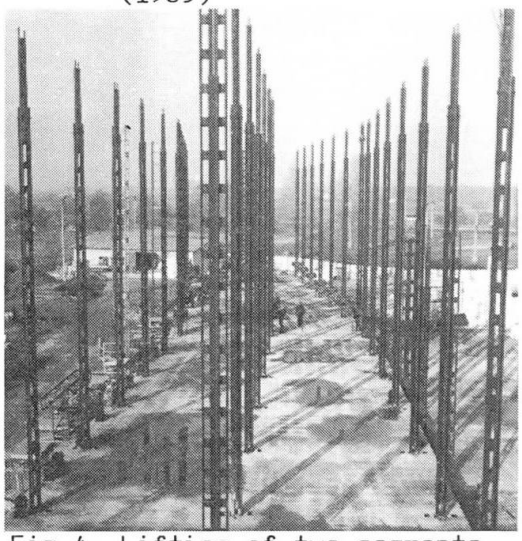

Fig.4. Lifting of two segments of a hospital building with column spacing 6.00x6.00 m, before lifting

After seating of the last floor slab there follows the disassembly of lifting device and the sliding bars.

In a building structure, realized by this method, there exists the possibility of execution of finishing works at all floors at the same time.

4. LIFTING DEVICE

The lifting device seated on the sliding bars consists of:
- bidirectional walking hydraulic jacks,
- head frames resting on hydraulic jacks,
- short hammer hangers suspended on head frames, for individual suspension of floor slabs.

The hydraulic jacks set is centrally fed and controlled.

5. THE COLUMN ZONES OF THE FLOOR SLABS

The floor slab is seated on two-piece, ribbed steel wedging collar. This wedging collar supports on bearing collar of the column. The cone-shaped opening in the floor slab for the column permits to get an immediate rigid connection by wedging effect after seating of the floor slab. This detail required an execution with great exactness. Some proper outfit permits an easy solution of this problem.
After finishing of the lifting process, the free spaces of these connections are to be filled with concrete.

6. APPLICATION

The Floors-Up-Technics may be applied to realize buildings with column-slab, core--column-slab, core-hangers-slab construction, etc.

The column axis arrangement can be free, but with regard to several criteria, e.g. function, material consumption, etc., it should be individually optimized for each building.

The appropriation of the buildings may be free, too, e.g.: dwelling houses, office buildings, industrial buildings, trade and service buildings, hospitals, schools, hotels, etc.

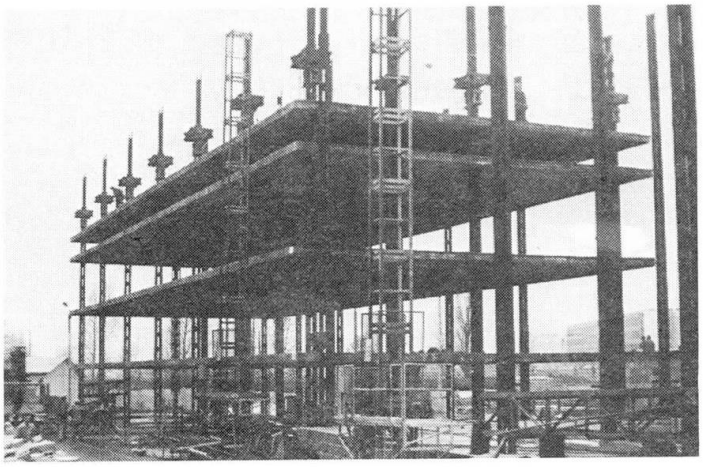

Fig.5. During lifting of first segment

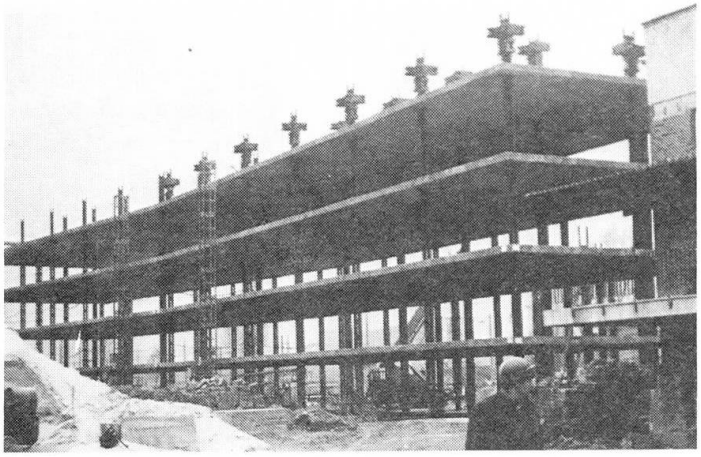

Fig.6. After lifting of second segment

7. EFFECTIVENESS OF THE TECHNICS

The awaited and at many building sites proved effectiveness of this building technics may be classified as measurable and not measurable.

Measurable Effects:

1. Low consumption of basic structural materials together with casing 600-800 kG/m^2; including steel 14-22 kG/m^2.
2. Almost complete elimination of forms, shultering and scaffolding.
3. Elimination of heavy mounting equipment.
4. Short realization time, e.g.:
   - floor concreting ca.100 m^2/h
   - floor lifting average 2.0 m/h
5. Low labor and energy consumption while the realization process, e.g.: running of 12 lifting jacks needs energy of 25.0 kW, which results in 0.025 kWh/m^3 of the building.
6. Shortening to a minimum of transport roads and diminution of reloading number.

Not Measurable Effects:

1. Application possibility at each terrain and in each surrounding.
2. Freedom in forming the plan, function, elevation and building firgure.
3. Complete elasticity and mobility of the function during exploitation, because all walls are the filling elements only.
4. Free choice of housing materials.
   Preferable are materials of great durability, low weight and high isolation parameter.
5. Minimum necessity of building site.

The respective effectiveness indicators can be controlled and modified during the designing and realization. Though it demands highest professional qualifications from both the designers and specialists attending the technology.

8. FURTHER DEVELOPMENT OF THE TECHNICS

The realization of building series in "Floor-Up-Technics" had begun in Poland in 1983. The number of realized buildings and the ones being at different stages of preparation and realization, of different appropriation and magnitude exceeds 20.

In the Building Engineering Institute of the Wrocław Technical University there had been created a specialized team of engineers which performs:

1. Basic studies, analyses and researches on the described technology.
2. The works bound with designing, improvement and implementation of new elements and solutions.
3. Working out of new and improvement of existing designing methods especially computer designing.
4. Research on completed buildings.
5. Instruction of specialists to technology attendance.
6. Co-operation with inland and foreign partners.

At the present three remarkable building establishments realize projects using the Floors-Up-Technics.