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The stages of demolition of buildings of the first industrial generation

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Abstract: This article analyzes the housing of the first industrial generation. Moscow still has a great number of residential buildings of the first industrial generation with a total area of about 25 million m². That is about 8.000 buildings with at least 1.6 million residents. A large part of such buildings is in critical or almost critical condition.

The magnitude and complexity of the solution to the problem of housing renovation of the buildings of the first industrial generation have determined an approach different to the described above. The basis of this approach is a quaterly demolition including the total area of all the uncomfortable housings with the subsequent building on the freed territories. The article examines the experience gained on demolition of five-storey residential buildings of the first industrial generation and reveals the steps and ways of their elimination by mechanical disassembling of structures using hydraulic shears. The authors propose a phased dismantling of the structures, beginning with the dismantling of internal systems, including equipment and devices, as well as finishing elements - removing of window frames and doors along with boxes, built-in cabinets, flooring (boards, linoleum, parquet, etc.). The article includes the list of the team cast to perform demolition work, together with indications of the workers and the equipment required. It also provides organizational and technological solutions for the storage of each kind of demolition materials and moving them into the heavy duty automotive container. The draft of production work is proposed to pay special attention to activities for the prevention of employee exposure to hazardous and harmful production factors (spontaneous collapse of structures and object elements, fall of floating structures and equipment, moving parts of construction machinery and cargo sliding, sharp edges of constructions and protruding rods, high concentration of dust and hazardous substances in the air at the workplace). The order of demolition of five-storey residential buildings must include implementation of a complex of preparatory activities, including the organization of building site, dismantling of internal and engineering systems and finishing elements, demolition of buildings using excavators-demolishers equipped with modern attachments including hydraulic shears.

Key words: 5-storey residential buildings, means of demolition (disassembly), dismantling of engineering systems, mechanical demolition, control and supervision

1. Problem Statement

Residential buildings of the first industrial generation were K-7, 1605AM, 1MG-300, II-32, II-35, 1-515, 1-501-511, etc. The bearing structures of the pioneer series (K-7, 1605, II- 32, II-35) are transverse walls - reinforced concrete or vibro-brick panels with a pitch of 3.2 m, and later series - longitudinal external and internal walls. We should note a sufficiently high level of prefabricated unified



structures and elements. For example, as a foundation, there were used continuous footings from pre-fabricated reinforced concrete blocks or pile footings with modular or monolithic raft foundations, and the socket walls were made of double reinforced-concrete panels, vibro-brick panels, three-layered sandwich of two plates of shells with a lining of insulation. The roof was done often rolled, flat with internal drainage and less often as metal one on the wooden boardwalks.

The average duration of construction of the building was about 1.5 months. Such high rates of construction allowed to provide apartments to about 55 million people for the period of 1956-1980. For example, there was built over 670 thousand m² of total residential area in Moscow between 1956-1960, and for the period 1961-1965, this figure had increased more than 15 times (table. 1). Totally in Moscow, there was built 36 million m² of living space in the period of 1956-1985.

Table 1. The Housing Fund of the first industrial generation (fragment) in Moscow

House Series	Year of construction	Area, m ²	Number of sections
1605 AM (5)	1956-1960	40566	38
2-32(5)	1956-1960	13918	13
2035(5)	1956-1960	11373	11
1MG-300(5)	1956-1960	110725	10
K-7(5)	1956-1960	126016	117
1-515(5)	1956-1960	375443	348
K-7(4)	1961-1965	157336	146
2-32(5)	1961-1965	1252325	1160
2-35(5)	1961-1965	74506	69
1605AM(5)	1961-1965	874492	810
1MG-300(5)	1961-1965	91593	85
K-7(5)	1961-1965	2639998	2444
1-515(5)	1961-1965	4671380	4325

In September 1994 the Moscow city Government approved a decree No. 735 "About the priority measures of the program of complex reconstruction and modernization of residential five-storey buildings of the first industrial housing, the continuation of works on reconstruction of buildings" which marked the beginning of active demolition of five-storey prefabricated housing [1, 2, 3].

As the result, over the next twenty years in Moscow there were demolished about 1700 residential buildings of the first industrial generation with a total area of 11 million m².

Thus, only in Moscow the total area of the residential buildings of the first industrial generation is still about 25 million m². And it is about 8,000 buildings in which there are at least 1.6 million occupants. The significant part of these buildings is in critical and precritical condition. The overhaul does not make sense because of design features of buildings and small apartments that do not meet modern requirements.

The scale and complexity of solving the problem of renovating the housing stock of the first industrial generation have predetermined an approach which is slightly different to the compared to the above. The basis of this approach is a quarterly demolition of buildings with coverage of all uncomfortable housing area with the subsequent comprehensive development of the freed territories.

However, the experience of the demolition of five-story buildings is certainly used in the new Program of Renovation of the Housing Stock. In this regard, its developers completely reject the mechanical demolition of the building structures with excavators, as this activity produces a large scattering of pieces of the destroyed structures, strong dust emission and noise generation, as well as a significant increase in the complexity of the sorting and shipment of the demolition materials [4, 5, 6]. To replace this method of demolition of buildings there were involved the modern excavators-destroyers, equipped with hydraulic shears, bucket, hydraulic hammer and grab.

2. Materials and Methods

The experience of past years has shown that the most important factor in efficient organisation of demolition work of residential buildings is appropriate and timely implementation of the complex of preparatory activities and works [7, 8, 9]. First, you need to get the customer's permission to eliminate the buildings as well as documents confirming the disconnection of electricity, gas, water, heat, sanitation, communication networks, radio and television, determine the order of works on the construction site and assign responsible for performed work, fire safety and electrical safety, arrange the construction site to install fencing, organize a residential compound and warehouses, arrange, if necessary, temporary roads and temporary power supply, install safety signs, etc. [10, 11]

Secondly, before the start of the demolition of a building all internal engineering systems must be dismantled, including engineering equipment and devices, as well as finishing elements – removing window frames and doors along with boxes, built-in cabinets, floorings (wooden planks, linoleum, parquet, etc.). Work within the building shall be made on the risers (entrances), starting from the fifth floor by an integrated brigade consisting of: assembler - 4 persons, rigger - 2 persons, workers of building trades (electricians, carpenters, plumbers, roofers, etc..) - 8 persons. The demand for building tools in Brigade is given in the table. 2.

Table 2. The demand for building tools

No.	Name	Model	Mass, kg	Quantity, pcs.	Function
1	2	3	4	5	6
1	electric corner cutting machine	MES-2204	5	2	cutting metal pipes, water, gas, heat-conducting pipes
2	electric circular saw	IE-5109 (disc diameter – 200 mm)	7.8	1	wood sawing
3	jig saw	IE52019	2.5	1	sawing wood, wood particle board, dry plaster, etc.
4	electric hand hammer	IE-4213A	7.8	2	auxiliary works
5	electric hand drill	IE-4713	3.2	2	auxiliary works
6	hand pneumatic scrap	IP-4609	18	2	auxiliary works
7	scarpels for stone and concrete works	IP-661 IP-581		2 2	auxiliary works
8	wood saw			2	auxiliary works
9	metal scraper			2	auxiliary works
10	linear forging hammer	K6, K8, K10		4	auxiliary works
11	hammer for metalworks			2	auxiliary works
12	mounting crowbar	LM20, LM24		2	auxiliary works
13	crowbar with claws	LG16, LG20, LG24		4	auxiliary works
14	two-wheeled cart			2	transportation of cargoes on the floor
15	one-wheeled cart			2	transportation of cargoes on the floor

The stage of dismantling of engineering systems and finishes requires careful organization of the processes of selection, sorting and storage of each type of demolition materials [4, 12]. After sorting materials on the floors of the entrance they are loaded through the window opening into a container, submitted with a crane close to the building wall of the corresponding floor. Each submitted container is loaded with one of the types of materials, after which the container is moved by crane to the appropriate storage area or overloaded in a heavy automobile container.

3. Results of research

These decisions should be reflected in the project execution plan, which should include [13]:

- the planned schedule of the performed work;
- construction general plan for the preparatory period;
- construction general plan for the main period;
- personnel schedules and major construction machines;
- technological routing to perform certain types of work;
- the list of technological (and dismantling) equipment;
- explanatory note including solutions for safety and health and environmental protection.

The following starting materials are used:

- working documentation for the reassembled object;
- results of the survey of buildings and structures;
- the technological regulations of the demolition of objects;
- geological, drawings of technological equipment, data about the presence of construction equipment and transport etc.

Decisions of the project execution plan should include:

- rationale for method of elimination of the object;
- determining the sequence of work;
- identification of hazardous zones and the storage of products of demolition;
- temporary pinning or strengthening of structures to prevent their collapse;
- methods of protection and justification of use of the protective devices of utilities;
- security measures during the demolition (dismantling) of buildings and structures;
- measures for environmental protection.

These solutions should contain measures to prevent the impact of dangerous and harmful production factors on workers – spontaneous collapse of the structures and elements of the object, falling loose structures and equipment, moving parts of construction machinery and moved loads, sharp edges and protruding structures rods, high concentration of dust and harmful substances in the air of working zone.

In addition, the work production projects can get additional requirements if work is done in the residential area. These requirements include: installation of protective devices of pedestrian crossings, work of mechanisms in cramped conditions, ensuring the smooth operation of plumbing systems and power supply systems, etc.

Requirements for production safety works must be complied throughout the process of demolition (dismantling) of buildings and structures. Workers are allowed to work only after the completion of briefing on workplace safety taking into account their features. In addition, they should be taught the safe methods of terminating the electrical impact on the person and providing first aid in case of the electro-injury. Every employee must know and follow fire safety regulations and avoid actions that could lead to fire or fire hazards [13, 14, 15].

Before starting work, you should ensure the stability of the structures and elements and, if necessary, securely fix them in accordance with the decisions of project works. The work is immediately stopped in case of a possible destruction of structures, and the workers must leave the dangerous area.

When removing the object, the ceiling openings and walls must be closed by the inventory solid boards or have a reliable temporary fencing. When performing work in unfenced areas with height more than 1.3 m (ceiling panels, slabs of balconies, exterior wall panels, elements of stairs and roof) workers use the spring hooks for mounting belt attached to the tense rope or anti-altitude device.

Demolition (dismantling) of buildings and structures must not be performed if there is a fault of tooling, fixtures, tool and means of protection of workers, as well as in case of low light at the work place or having too much litter, in the rain, in the fog, snowfall and wind blow force over three points. It is prohibited to exit workers out temporary fence without a safety belt, locked on the secure rope of the fencing.

Before starting the production work the workers are to [14]:

- review the status of workplace, conditions, and volumes of forthcoming works;
- get training on labor safety;
- get clothing and personal protective equipment;
- obtain, verify and set up the tooling, means of mechanization and equipment;
- check and prepare the scaffolding tools and inventory protections;
- check security of passes and the workplace.

Technical, production, administrative, and field supervision of compliance with occupational safety, fire safety, electrical safety and conditions of work should be carried out throughout the period of demolition of the building.

Technical supervision of the customer performs control of the matching of sequence and performed technological operations, technological and normative documentation; compliance with the technological regimes established by projects of production operations, technological routings and regulations; monitoring compliance with the contractor rules of warehousing and storage of parsed materials; control of performed work by the requirements of bodies of state supervision and local self-government; notification of public oversight of all cases of emergency condition at the site of disassembly of the building; control of conformity of volumes and deadlines to the contract and schedule of disassembly of the building; final assessment (together with the performer of works) the conformity of the accomplished disassembly of the object to requirements of the legislation, project and normative documents [10, 16].

The field supervision of the developer of design documentation vivifies control activity and performs selective monitoring of compliance with technology of production works; compliance of the requirements of the project of performed work on dismantling of the building; informing the customer about delays and poor implementation of instructions of the specialists carrying out supervision for operative measures on elimination of the revealed deviations and violations of regulatory requirements.

Technical supervision of the territorial bodies of the Federal service for ecological, technological and nuclear oversight identifies all the violations of rules, norms and instructions on industrial safety, including the adherence to fire safety; gives instructions about elimination of the revealed violations; monitors the activities of the oversight service organization – owner of the cranes; monitors the safe operation of cranes on construction sites; monitors compliance and proper implementation of the requirements of the project of performed work; selectively verifies of the knowledge of rules and regulations of industrial safety of the specialists and workers of the monitored organization; checks the implementation of work regulations, orders and instructions, previously issued by the officials of the parent bodies.

Regional sanitary and epidemiological surveillance bodies control over timely passing of the workers' medical examinations; provision of workers with means of individual protection, as well as a certified special clothes and shoes.

Administrative supervision of local authorities maintains control to determine adverse impact of construction works on the population and the territory in the zone of influence of the ongoing demoli-

tion of the building; control the conditions of work (size of the fence around the construction site, work schedule) as well as the conditions of environmental safety and holding clean environment (garbage disposal, the maintenance of order on the adjacent territory, etc.).

4. Conclusions

Demolition of prefabricated five-story apartment buildings, as not corresponding to modern requirements is the only right direction for the renovation of the housing stock of the first industrial generation.

It is advisable in the development and implementation of the Program of Renovation of the Housing Stock to leverage the accumulated experience of the past years. The order of demolition of five-storey residential buildings should include the performance of a complex of preparatory activities, including the organization of the construction site; dismantling of internal engineering systems and finishes; demolition of buildings with the help of excavators-destroyers, equipped with modern attachments, including hydraulic shears. Also we need to pay special attention to the safety measures of the workers during the implementation of the demolition work.

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