Floors lift technique in old building retrofitting

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Abstract
The current article proposes the idea of using floor lift for retrofitting of living spaces and premises under conditions of dense urban building and analyzes the feasibility of the claimed issue. We report on the advantages of the method described in the article over the other constructional techniques, which require floors substitution or embedded structures erection.
Key words: RETROFITTING, LIVING SPACES, PREMISES, FLOORS SUBSTITUTION, EMBEDDED STRUCTURES, FLOOR LIFT TECHNIQUE, MONOLITHIC CONSTRUCTIONS

Retrofitting of the living spaces located in the old city, which in most cases are of historic value and create the architectural signature of the city centre, is definitely a significant problem of the present day. The urgency of this problem is explained by the necessity for us to meet the conditions when we need to

maintain architectural integrity of the historical buildings and at the same time to adapt their constructions and designs for the modern conditions of operation. The main reason, why retrofitting is demanded, is that the existing old buildings with timber floors designs do not meet the contemporary conditions. Moreover, due to long years of operation, the timber floors are usually in dad conditions and require substitution as they cannot withstand under new increased operational loads. One of the methods to refurbish such buildings is to erect embedded systems while preserving their closure constructions (Figure 1). The retrofitting works have the specific feature: they are carried out under conditions of dense urban area and, in particular, within the historical centres, therefore the very limited area of the construction site is their characteristic.

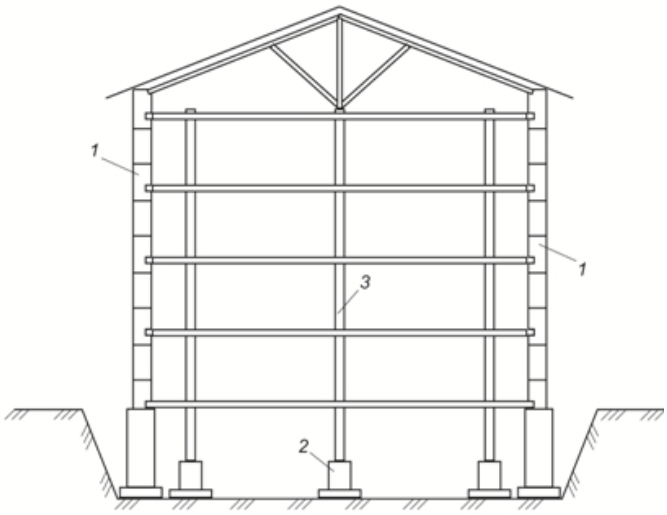

Figure 1. House retrofitting with embedded systems:

1 – existing closure constructions; 2 – embedded system foundation; 3 – embedded constructions

This crucially affects the opportunities to apply the building machines and cranes on the site. Moreover, the work of a crane under these conditions in some cases demands the relief of traffic or even traffic interruption within the neighboring areas for a long period of time and in other cases the use of cranes is absolutely technically impossible. This makes builders eliminate the use of assembled reinforced concrete structures but apply monolithic reinforced structures as embedded carcass work. However, the operations with monolithic reinforced structures are also performed with cranes because they lift reinforcing carcass and formworks. One of the techniques, which allows us to reject cranes completely for embedded constructions, is the method of floors lift [1].

Based on the fact that the problem of old buildings retrofitting for living spaces and premises is very topical, a big number of papers have recently been published on this theme in Russia and Ukraine [2 – 6] as well as in other countries [7 – 15]. The publications [2 – 6] discuss the specific features of old buildings retrofitting, problems of building machines operation within the tight building site and compare application of reinforced concrete structures assembly versus monolithic reinforced structures. The above authors conclude that old building retrofitting with the techniques of floors substitution and embedded constrictions enables us to sustain the architectural face of the city and meet the new requirements for building operation. The other papers are devoted to the case studies on retrofitting [7 – 9], reinforcing the constructions of the historical buildings [10 – 12] and general problems of older buildings retrofitting [13 – 15].

Despite a big number of publications devoted to the above stated problem, there is still no solution how to obviate completely the use of cranes while retrofitting old buildings though this permits us to ease building works organization on a small construction site and to exclude intervention into traffic on the nearby roads. This issue is still open for discussion.

The presented article aims at the contributing to the problem under discussion by reaching the targets as follows:1) to analyze the specific character of floor lift technique within the method of embedded constructions erection for both living spaces and premises retrofitting; 2) to outline the advantages of the mentioned technique over the other ones.

As it has been stated [1], floor lift technique in building carcass multi-storied houses with monolithic reinforced concrete framing or assembled and monolithic one is based on development of the floor on the ground surface or on panel floor, over the substructure of the whole panel floor arrangement. After placing the panel floors and obtaining the required hardness of the concrete, the panels are lifted against the previously settled columns by the hoist means in the position designed by the project. This technique consists of the following order of works to be performed: 1) construction of the substructure by the conventional methods, which demand the foundation construction for the columns, mounting of the underground parts of the columns, arrangement of underground parts of the closure structures, etc. (Figure 2); 2) installation of stiffening core to ensure the steadiness of the house both transversely and longitudinally; stair enclosures and lift shafts are, as the rule, located within the stiffening cores; 3) mounting or installation of the monolithic columns of the first tier; 4) arrangement of all the panel floors within the building lines to cover all the building area or the bay; 5) after the concrete pad

with the panels is hard enough, the panels arrangement is lifted by into the intermediate position, these operations are carried out by means of the hoists fixed against the columns; 6) mounting or installation of the next column tier, shift of the hoisting means and lift of panel floors; 7) after all the floors are lifted and set into the positions required by the project, the hoists are removed, the builders construct the roof, mount the closure structures, and perform all the general and decoration works.

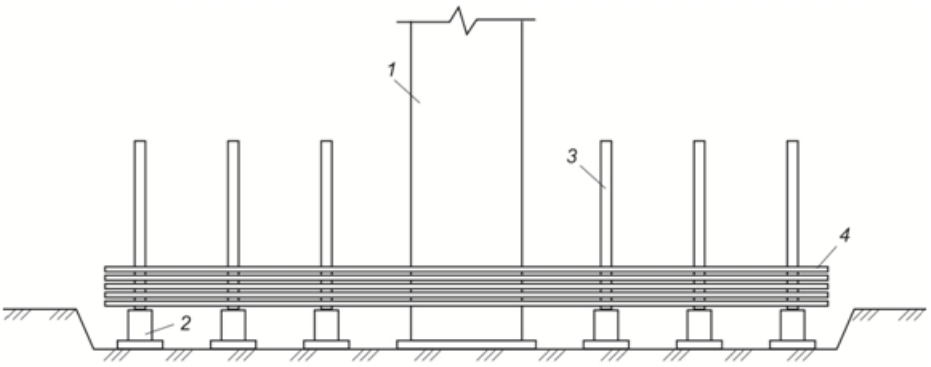

Figure. 2. Building by floor lift technique:

1 – stiffening core; 2 – foundation; 3 – columns; 4 – packages of panel floors

Among the advantages of the above-described technique, one can single out the shorter period of cranes operation (in some cases their elimination), greater reduction in the construction site area and freedom of engineering solution choices on designs and constructions owing to the absence of the load-bearing walls.

This technique was initially developed for building new houses and had not been considered as one for retrofitting of refurbishing.

However, the analysis on the technique advantages implies that its use for retrofitting and refurbishing with the approach of embedded systems erection would enable the works to be carried out within the area limited by the conditions of dense urban districts. The floor lift technique with its feasibility to eliminate the cranes permits the reduction in the site area nearly to the room of the house under construction. Thus, there is no need to impose the traffic relief or interruption, to ban the pedestrian movement or to interferer with operation of the nearby houses.

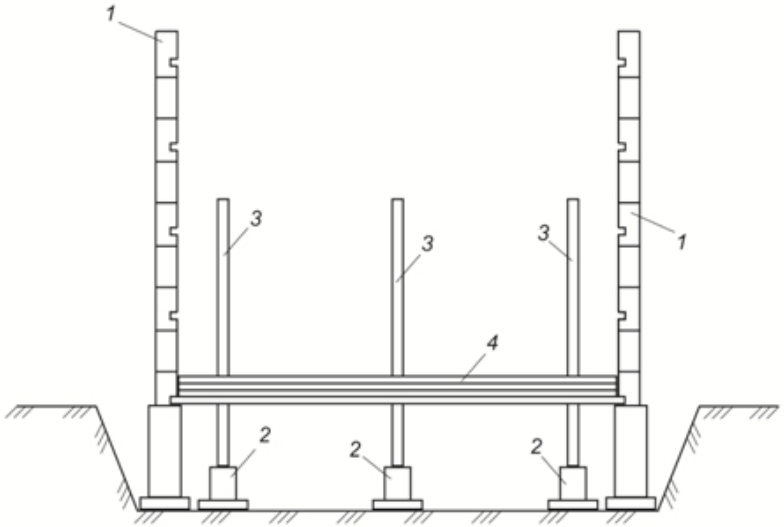

Figure. 3. Layout of the embedded carcass. Floor lift technique at the stage of concrete placing for the panels floor:

1 – existing walls; 2 – foundation for the embedded carcass; 3 – columns; 4 – panel floor arrangement

We find it reasonable to describe the work organization structure when we apply the floor lift technique for retrofitting:

1) dismounting of the house internal constructions:

performing this works, one should strictly observe the sequence requirements of the dismount maps; strengthening of closure constructions are to be carried out if necessary;

2) ground processing for the embedded construction foundation, and installation of monolithic foundations for the embedded constructions. The concrete mixture could be prepared on the site and supplied by a concrete pump, set within the house area. As the concrete is hard enough, waterproof sealing of foundation and back filling with compacting are performed. The operation of concrete pad placing into the underground part of the house is the operation on requirement or optional;

3) installation of the monolithic columns of the first tier. The formwork and the reinforcing carcass are lifted from the scaffold while the concrete mixture is supplied with the pump;

4) installation of monolithic floor plate over underground house part; concrete is supplied from the single point and introduced into the formwork with the pump, located at the external part of the house;

5) after the concrete plate becomes as hard as required, all the panels of the arrangement are places on it, in a way of one panel after the other one (Figure 3); the panels are separated with the distributing layer;

6) as the concrete hardens more to the required value, the scaffold, the formwork, the reinforcing carcass and a light pump are placed on the last panel with the objective to perform concrete works for the next column tier;

7) the hoists to lift the panel arrangement are mounted on the first tier column heads[1]; the panels are lifted into the intermediate positions and fixed (Figure 4);

8) concrete works of the second column tier;

9) the lifting is not continued until the column concrete is not hard as demanded; the last two steps of the described procedure are repeated again before we complete the concrete works for the last column tier; at the final stage, the joints between the columns and panels, the ones between the panels and enclosure constructions are filled and the concrete pump is removed by the crane. The surface cover, internal works and decoration works are carried out with the conventional techniques.

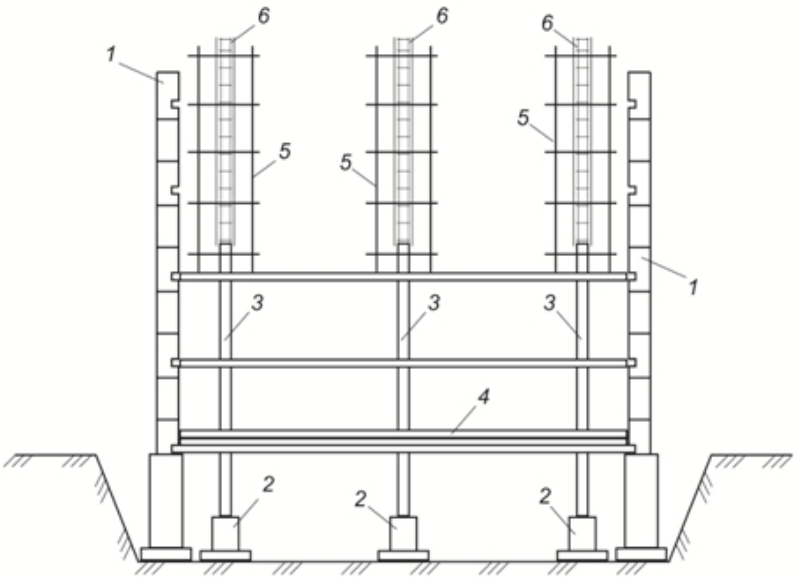

Figure 4. Embedded carcass installation with the floor lift technique (Concrete procedure for the second column tier):

1 – existing walls; 2 – foundation for the embedded carcass; 3 – columns; 4 – panel floor arrangement; 5 – scaffold; 6 – column formwork

The above described work procedure evidences that the technique proposed in the current articles enables us to minimize crane operation during the retrofitting of old buildings. This enhances building planning scheme ratio up to 60 – 80% while the conventional techniques possess the ratio of 10 – 40%. The method we propose excludes installation of the formwork for panel floor arrangement and the supports to bear it owing to the possibility to use the panels priory made with concrete as the formwork for the following ones. Thus, the drastic decrease in labour hours is achieved with the operations on panel floor.

However, the use of the lift technique under conditions of embedded systems erection foresees manual works for column formwork assemble, instal-

lation of reinforcing carcasses into the formwork as well as mounting and dismounting of the scaffold and the hoists.

Conclusions

The floor lift technique proposed in the current article foresees installation of carcass type embedded systems made from monolithic reinforced concrete and could be applied for retrofitting of the living spaces and premises. The rationality of this technique application becomes obvious after economic comparative analysis versus the other techniques used under the similar conditions.

The floor lift technique allows almost complete elimination of the cranes to be applied on the site and significant (50%) reduction in construction site area as compared against the techniques which use the cranes for embedded construction erection. Retrofitting work with the floor lift technique does not interfere into the traffic of the nearest areas and permits the construction operations under conditions of the dense urban districts.

One of the criteria to make the described technique feasible is the presence of the stiffening core in the house. The walls of stair enclosures, which are left untouched by reconstruction and does not undergo dismounting, could serve as the stiffening core.

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