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ORGANIZATION AND TECHNOLOGICAL STUDIES ON BUILDING RECONSTRUCTION USING CONVENTIONAL AND MODERN METHODS

This article represents a short organization and technological analysis of finalizing the construction, using both conventional work materials and modern lightweight structures of fast assembling. The studies are done on the basis of «L» teaching block, which is in Poltava National Technical Yuri Kondratyuk University. Results of the study showed that it needs reconstruction. All-inclusive organization and technological and economical comparison of these two variants of the buildup proved that it is more advanced to carry out building works using modern technologies, even though they need more manpower effort and are more expensive. Nowadays we can observe a tendency to widely use fast mounting structures and it will only become more wide-spread in the future, which will inevitably result in both technologies and engineer construction equipment cheapening.

Keywords: *reconstruction, erecting, conventional work materials, light gauge steel framing, thermal modernization.*

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ОРГАНІЗАЦІЙНО-ТЕХНОЛОГІЧНІ ДОСЛІДЖЕННЯ РЕКОНСТРУКЦІЇ БУДІВЛІ З ВИКОРИСТАННЯМ ТРАДИЦІЙНИХ ТА НОВІТНІХ ТЕХНОЛОГІЙ

Подано короткий організаційно-технологічний порівняльний аналіз добудови об'єкта з використанням традиційних матеріалів та сучасних легких конструкцій швидкого зведення. Дослідження виконано на прикладі навчального корпусу «Л» Полтавського національного технічного університету імені Юрія Кондратюка, який на основі результатів обстеження потребує реконструкції. Комплексне організаційно-технологічне та економічне порівняння двох варіантів надбудови довело, що, незважаючи на більшу трудомісткість та вартість, перспективним є варіант зведення будівлі за сучасними технологіями, оскільки вже зараз складається тенденція до широкого застосування конструкцій швидкого монтажу, й у майбутньому їх масовість лише зростатиме, що неминуче призведе до здешевлення технологій та засобів механізації.

Ключові слова: *реконструкція, зведення, традиційні матеріали, легкі конструкції, термомодернізація.*

Preface. Nowadays reconstruction of building is becoming more and more essential. At present there are plenty of edifices, erected at the times when low energy prices made it possible to hasten the construction, lower the prime cost, and reduce specific consumption of materials and manpower effort. For this reason a great body of buildings bears the signs of extremely low degree of heat insulation which results in significant heat loss needed to maintain necessary microclimate parameters. Again, defects are multiplying themselves during years of exploitation which leads to early amortization of constructions.

The only way to prolong the useful life of such buildings is to reconstruct them. This supposes thermal modernization of external protective grates, building up more floors, and replacement of certain worn-out parts of the construction with the new ones. At the preparation level the most important task is to choose proper organization and technological scheme, which should be developed with account for existing building condition, the most productive sequence of work, and materials used. At this stage it becomes possible to use such advanced modern materials as light gauge steel framing, cast reinforced concrete and gas-concrete blocks along with conventional materials such as brick and precast concrete. It is rational and thorough choice of materials and method of building activity that allows not only to cheapen and accelerate building reconstruction, but to grant its safety during whole useful life.

Survey of the latest studies and publications. The subject of the building reconstruction technology is studied in the works of great number of scientists [1, 2]. They tend to reduce the use of building cranes, especially if there is an existing erection [3]. The researchers also actively work on improving light gauge steel framing by filling hollows with light concretes in order to reinforce their firmness and strength [4]. Technology of erecting buildings with the help of light gauge steel framing is extensively developed abroad. [6, 10, 11, 12].

Focus on the unsolved parts of the major problem. Although restoration process nowadays implies using both conventional and latest materials, thorough comparative organization and technological analysis of these two methods hasn't been carried out. Consequently, building contractors, designers and customers don't have an opportunity to quickly judge about costs and efficiency of the chosen method themselves. This has a negative effect on the constructing process as a whole and prevents from introducing innovative methods into building industry.

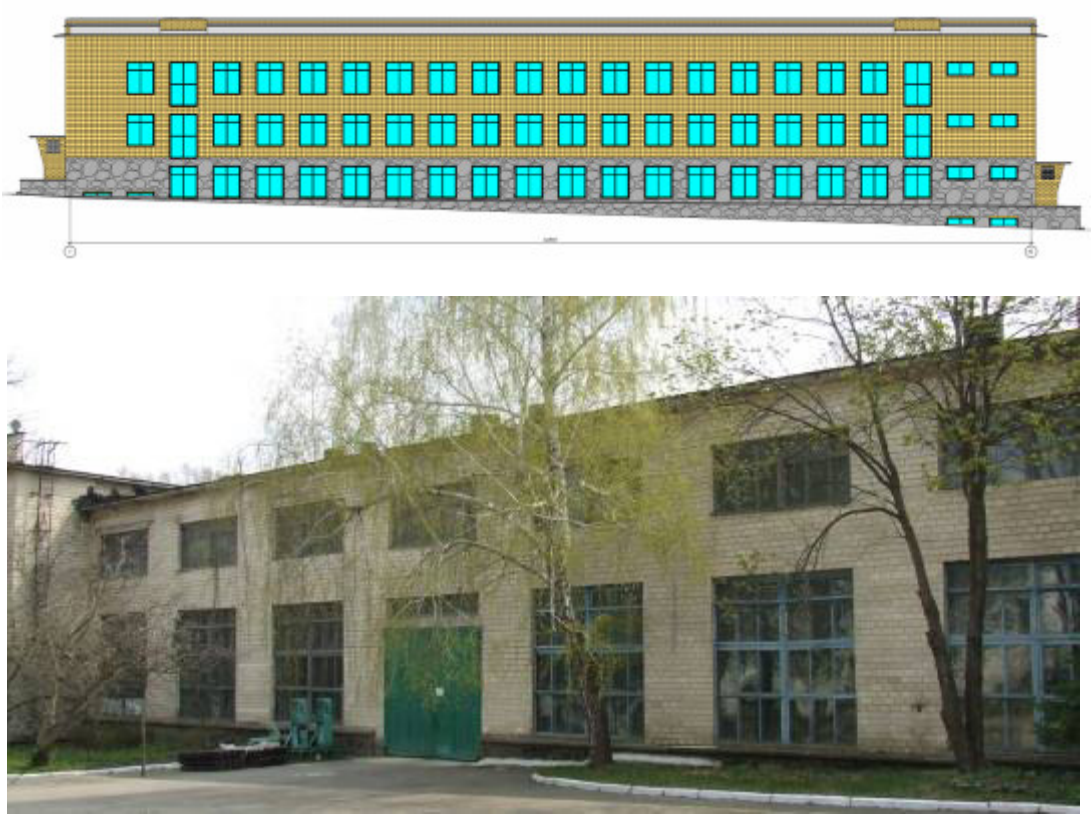
Problem formulation. Taking into account the fact that building sector urges to receive intrinsic data on how efficient these two restoring methods are, a need in integral assessment of conventional and modern ways of constructing arises.

Baseline and results. To carry out comparative analysis we chose «L» teaching block, which is in Poltava National Technical Yuri Kondratyuk University. Inspection results have shown that the edifice demands full and complete renovation [7, 8]. This also involves adding another storey to the existing building (Fig. 1).

At present the «L» teaching block is represented by a two-storeyed Г-shaped building with the measurements of 45,8x66,8 in the outer axles. The edifice has a basement storey and an apparatus floor with an overflow section at 9,675 m.. The structural diagram of the building is non-carcass with spine walls, foundation is in the shape of dimension stone footing, walls are made of loam bricks, bonded by mortar and are 510mm thick, the outer face is decorated with the ceramic wall tile. Flooring is made from the hollow core slabs of different shapes and sizes; roofing is assembled of jointed ribbed slabs, sized 1,5x6 m. It bears against reinforced concrete double T-rails 2Б012-5 with a beam span of 12m and a step of 6 m. and is located above the laboratory (axes В-Д). The pitch makes 7°. Roofing is soft, made from coarse-grit ruberoid; canalization is external, unstructured.

Height from the finished floor level to the bottom of the baseplate is 8,25 along E axis and 9,76 along B axis. The laboratory is equipped with a travelling crane with the capacity of 10 te and an overhead-track hoist with the capacity of 1 te.

a)



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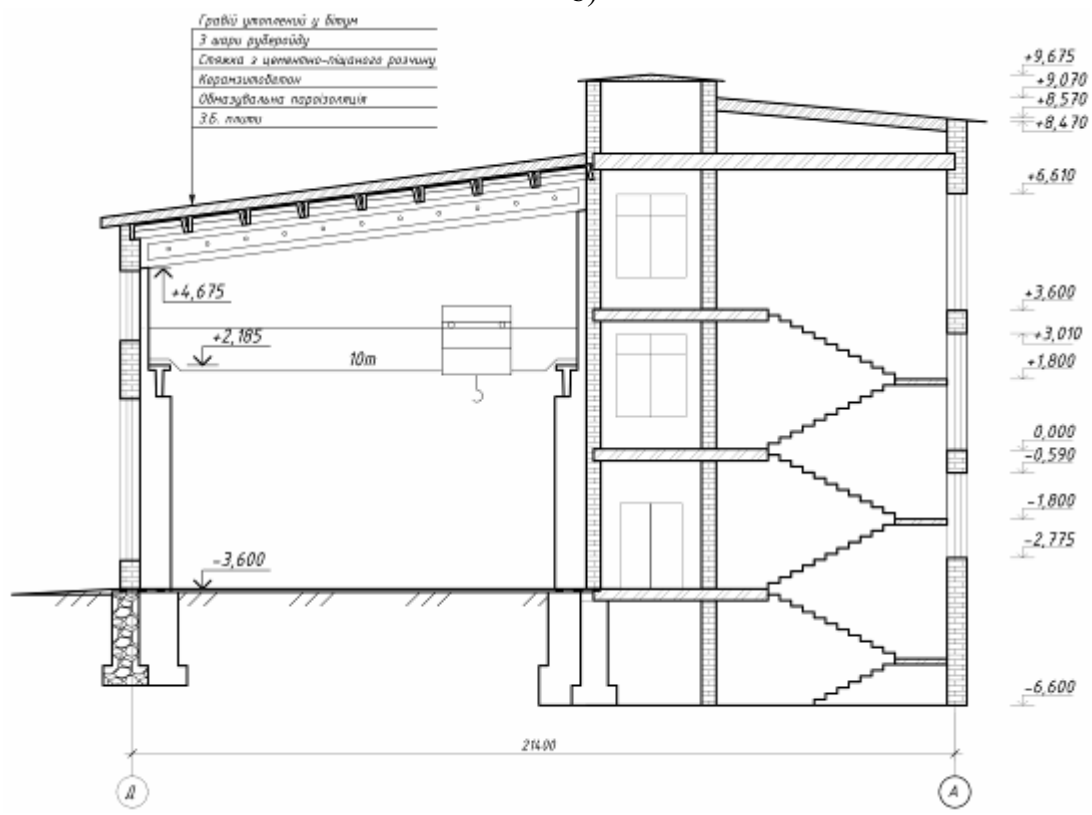

Figure1 – Front elevation and overall view (a) and sectional elevation (b) of «L» teaching block before reconstruction

The teaching block restoration should result in building up the third floor with a conference hall and a showroom right above the laboratory. While developing the trial design we considered two types of buildup, executed with the help of conventional materials and modern lightweight structures (Table 1). However, there was a common thing for both schemes – thermal modernization of the building, which could be fulfilled by mounting ventilated face using profiled sheeting.

Table 1 – Comparative analysis of two building reconstruction modes

№	Structural member of a building	Defined materials and constructions	
		1st variant (use of conventional technology)	2-й варіант (use of modern technology)
1	Flooring above the laboratory	Existing reinforced concrete beams, prestressed concrete building units and armoured concrete slabs	Existing reinforced concrete beams, site-cast reinforced concrete flooring 15 mm thick
2	External and inside walls, partitions	Ceramic brick 380mm, 510 mm thick; gypsum plasterboard	Gas-concrete block 500 mm, 400 mm thick; gypsum plasterboard
3	Attic floor	Precast floor slabs	Light gauge steel framing application
4	Roofing	Metal tile roofing resting on lightweight trusses	Metal tile roofing resting on lightweight trusses

We also planned to carry out interior decoration, which was identical for both methods.

Apart from reconstruction it was essential to make a full organization-technological comparative analysis. This involved following steps::

- to analyse methods of how the buildup could be implemented, to develop flow diagrams;
- to analyse organization peculiarities of the building process;
- to calculate and contrast expenditures for both variants;
- to justify the most efficient method of constructing a buildup above «L» teaching block.

It should be noted that we tried to preserve the existing structural members of the

building to the uttermost. Consequently both cases expected roofing above the laboratory to be taken down, existing reinforced-concrete double T-rails to be mounted horizontally and the new flooring to be fixed on them. We carried out checking calculation for these rails considering new loads.

During process engineering we paid great attention to developing flow diagrams for blockwork using gas-conctrete blocks and assembling a floor using light gauge steel framing (Fig. 2). The peculiarity of such blockwork is that it supposes applying of the all-round reinforce belt, which will be able to redistribute loads while in operation. The standard flow diagrams appeared to be non-existing, as in Ukraine such design was introduced not so long ago.

It is also important to give a thorough consideration to the organizational peculiarities of the construction process. Application of the conventional work materials, namely brick and pre-cast reinforced concrete involves using of tracked lifting crane. Erecting the construction using light gauge steel framing, on the other hand, allows to use such means of mechanization as a mobile grout injection pump, tower hoist and trans palette. It is much more favourable to use them, as they all are of small size and rather convenient to be used in the existing buildings. However, erecting the building from modern work materials demands bigger amount of technological operations and considerable costs of manual labour. More specifically, settling

the timbering, connecting reinforced frames, establishing the all-round reinforce belt and mounting of light gauge steel framing are all the processes that need little use of machines. Moreover, level and standards of workers' skills and industrial practices ought to be substantially higher, then when constructing a building from conventional work materials.

a) b)

Figure 2 – Overall view (a) and light gauge steel framing flooring make-up (b)

Another important problem is expensiveness of the modern work materials and necessary equipment together with the growth of building period. The latter is the consequence of the fact that it takes quite a long time for the cast reinforced concrete to gain its designed strength. Organizational peculiarities of buildup constructing methods [5] are shown on designed master plans for the first (Fig.3) and the second (Fig.4) variants.

Values of the most critical organization-technological data appeared to be predictable. They are shown in table 2.

Table 2 – Values received in the comparative analysis of reconstructing methods

№	Subject and unit of measurement	Values	
		1st method	2nd method
1	General labour intensity, man-day	3741	4593
2	Constructing period, day	144	134
3	Maximum/average number of workers, person	40/27	50/34
4	Construction budget, thousands of hrn.	9919,5	11908
5	Overall production costs, thousands of hrn.	733,7	778,7

In order to specify given values we developed and improved construction calendar progress charts and calculated the cost sheet with the aid of software application АКВ-5. It is natural that using conventional work materials in constructing is less labour-consuming nowadays (by 23 %) and more profitable (by 20%), though it needs more time for implementing (by 7% or 10 days more)

Front and sectional elevation after building restoration using modern technologies (including thermal modernization) are illustrated on Fig.5. For the front face decoration steel profiled sheeting was used. It was mounted along steel galvanized siding. Highly-efficient mineral wool insulation is put directly on the external walls by means of expansion anchor studs and glueing. Such method of finishing is up-to-date and energy-saving and is widely used worldwide.

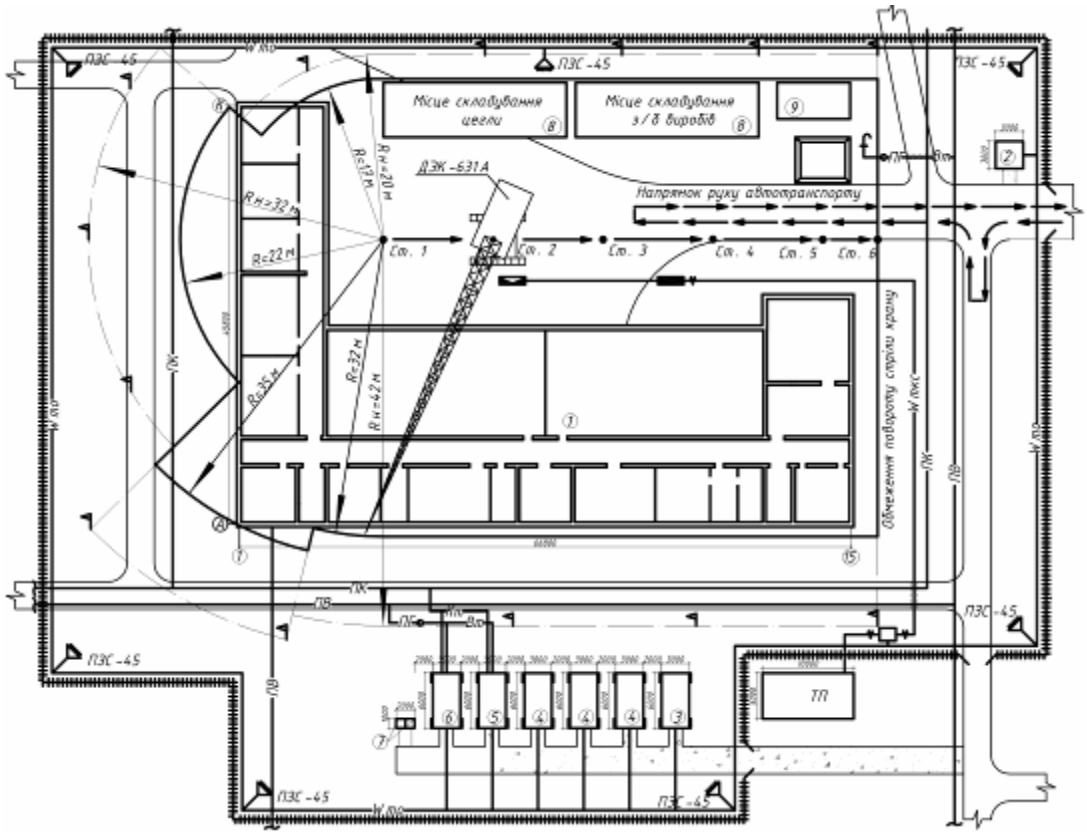

Figure 3 – Project of the overall lay-out when conventional methods are applied

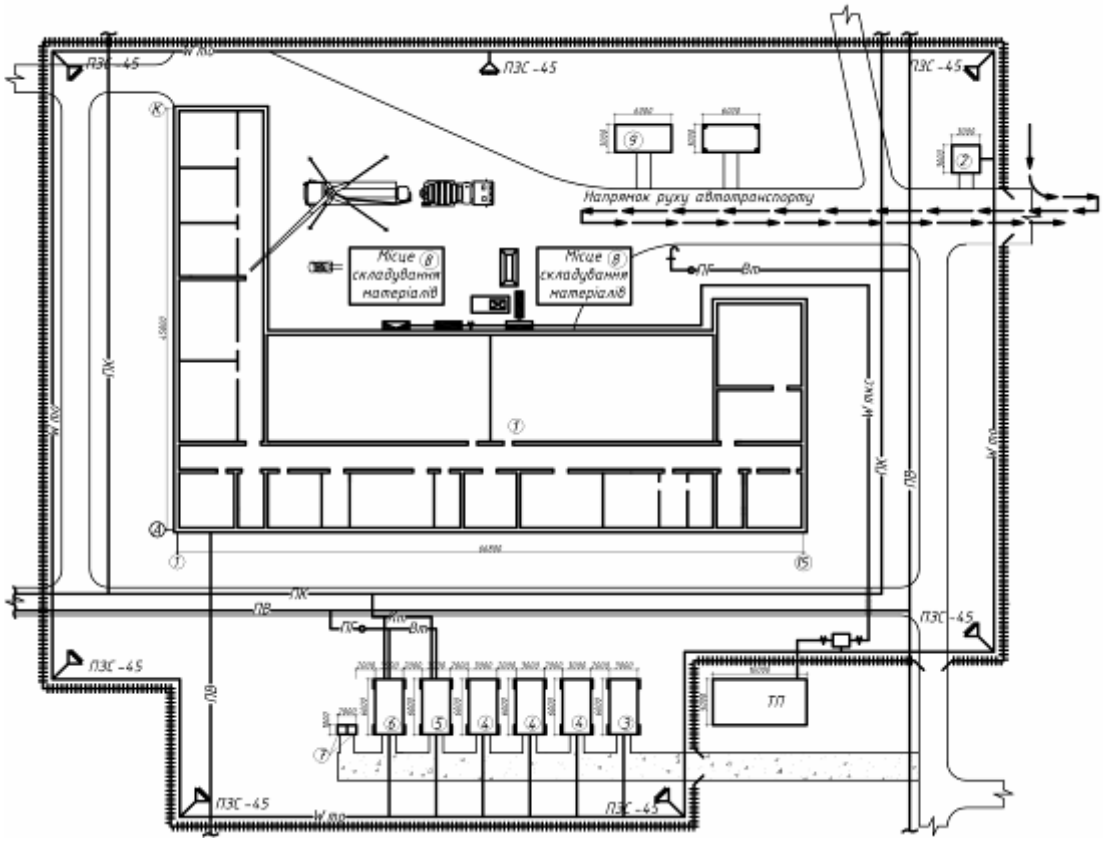

Figure 4 – Project of the overall lay-out when modern lightweight structures are applied

a)

b)

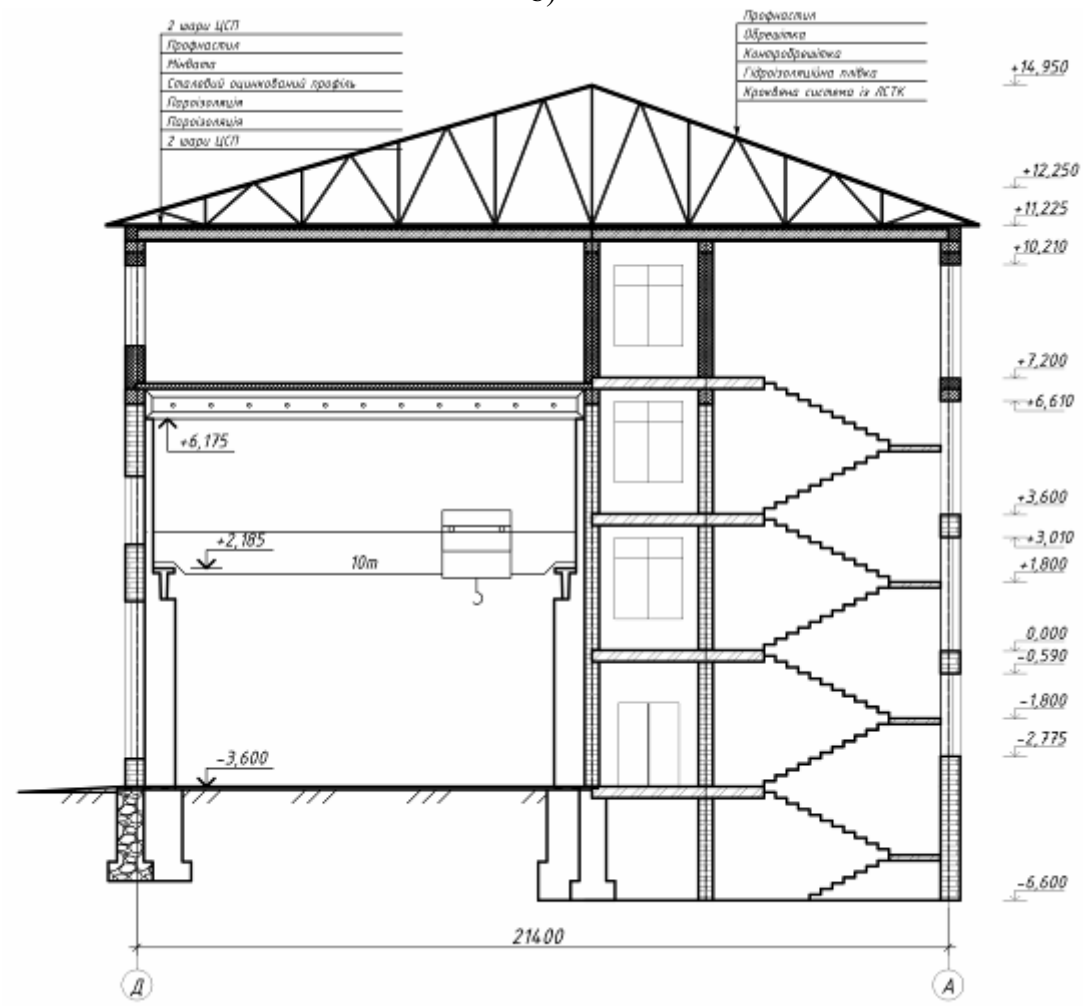

Figure 5 – Front (a) and sectional elevation (b) of «L» teaching block after applying restoration using modern technologies in restoration process

Conclusion. All-inclusive organization and technological and economical comparison of these two variants of the buildup on «L» teaching block, which is located in Poltava National Technical University proves that at present the method of using conventional work materials is less labour consuming, less costly and needs fewer workers on the site. However this method of reconstructing dictates longer constructing period. Despite all above-mentioned we can claim that erecting the building using modern technologies is more desirable and promising, as even now we can observe a tendency to widely use fast mounting structures and it will only become

more wide-spread in the future. Along with advancement and expansion of the technologies their prime cost will decrease. Taking into account the fact that comparative analysis was done for the single object, we should add more buildings to the comparison in our future studies in order to revise received data.

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