The decrease in capital expenditures of plumbing and sewerage reconstruction

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Abstract. Nowadays there are a lot of problems occurred in provincial towns and connected with 5-floor building renovation because of their moral and physical deterioration. Based on detailed researches of professor S Bulgakov and architect V Leont’ev, there has been made a decision regarding reconstruction of the old building stock instead of destroying it at all. It’s connected with some economic expenditure and it’ll help us save historical view of these little towns. By the way, it has some influence on engineering reconstruction that includes plumbing and sewerage as they should be profitable in case of capital expenditures.

These questions have been worked through by famous Russian scientists such as V Kedrov, E Lovcov, V Isaev, A Ostavnov and foreign researchers Wilson E, McGaw BA, Li XY, Chu HP and others.

A lot of flat lay-out systems were analyzed. They had been popular and typical in 50-s. It was clarified that engineer plumbing and sewerage were in really obsolete condition and needed the capital repair. Besides, areas of the most functional spaces such as bathrooms or kitchens have some elements of engineering systems that are subject to restoration due to their small area too.

We know that usually partitions in these flats and houses aren’t bearing, so we have to refuse from the classical system of renovation. Recently the new way of plumbing restoration has been developed. It also depends on new types of architectural and planning solutions.

This new systems approach means point layout of risers on plans, line arrangement of water-diverting devices, choice of new water pipe materials and etc. It’ll let us decrease total loss and choose the best pump equipment saving a large number of pipes during installation. By the way, using new water-tapping devices and fittings (water-saving nozzles) will help us extend the service life of the total system up to the next capital refurbishment. To prove this there have been made some technical and economical comparison of classical and new methods of plumbing and sewerage reconstruction. As a result, the second one reduces expenditures in more than twice.

Keywords: renovation, expenditure, plumbing and sewerage restoration, lay-out systems, water pipe installation, methods.

1. Introduction

Nowadays the issues of old housing renovation, which can be attributed to the first standard building series of the 50's and 60's of the last century, become topical in connection with the economic crisis...
and unsatisfactory state of the old residential buildings. These are different types of five-storey block
and brick houses with outdated engineering communications (water supply, sewage, etc.).

In professional works of Bulgakova S and Leontyev V [1] the main issues related
to the reconstruction of these buildings, taking into account architectural and space-planning solutions,
but the issues of engineering networks renovations are not fully worked out.

The monograph proves the economic reconstruction feasibility. It is also important to say that this
question is relevant not only for large cities, but also for small and medium-sized towns. This will
attract the attention of new customers, offering new reconstructed housing with better ecology and
cheaper prices per square meter. For example, it includes cities located 30-40 km from the capital.

As for the engineering systems of plumbing restoration, it is in poor condition now. When
the house is reconstructed, it will completely change.

These questions have been worked through by famous Russian scientists such as Kedrov V,
Lovcov E, Isaev V, Ostavnov A and foreign researchers Kopeček P, Barnett F A, Gray S T, Tootle G
A and others [2-4].

In the Isaev’s works the main issues related to the transition to water-saving technologies
in plumbing systems. They include the use of non-contact water dispensers, anhydrous urinals,
as well as water-saving nozzles and toilets with two buttons for washing away contaminants [5-8].

In the scientific works of Retired A. you can find solutions to reduce water losses by using new
pipelines made of modern materials. In addition, there are some options offered to increase the quality
of equipment installation during the plumbing reconstruction [9-10].

Firstly, in the present article it is proposed to develop a new justified methodology for plumbing
and sewerage reconstruction, taking into account the above-mentioned problems and water
and resource conservation. Secondly, it is proposed to develop energy efficiency as these issues are
almost not paid enough attention.

The problem for such old buildings is further aggravated by the fact that the calculation
of the plumbing was made for standard water devices (a mixer over a sink, a faucet flush toilet bowl,
a single mixer above the bathroom and a washbasin). Now a lot of residents are installing a larger
number of devices, on which the system has not calculated (washing machines and dishwashers,
whirlpool baths, etc.). There were recorded cases of pressure drop among consumers on the last floors
(4-5 floors). That was due to increased water consumption and the use of a large number of water-
tensive devices.

A lot of 5-floor typical houses of the 50s-60s (1-510, 1-511, 1-515, etc.) have one indisputable
advantage – it is the demolition of partitions, which are not bearing [11-12]. This allows making
various redevelopment variants with increasing areas for reconstructed apartments and improving
the quality of living.

To the disadvantages of the reconstructed houses we can attribute very small areas of kitchens
and sanitary cabins, the presence of combined options even in two-bedroom apartments
that is unacceptable today. Thus, it is necessary to significantly improve the comfort of using
engineering systems, for example, plumbing and sewerage.

2. Methods

It is proposed to study and analyze the main space-planning decisions of typical series of houses
and offer their renovation method that will lead to reduction in capital expenditures for the facility
reconstruction.

Nowadays the main problem, arised in old and dilapidated housing renovation, is that the architects
involved in the reconstruction pay attention to the living quarters planning leaving the engineering
systems or their position in the space of an apartment house in second place.

In the process of development the bathroom underwent changes [13-14]. Taking into account
today's requirements for comfort its area should be increased, because there should be comfortably
placed and other water-diverting devices, that previously have not designed in the system.
For example, it is an automatic washing machine or a whirlpool bath. The level of hygiene and sanitation over the past 50-60 years has grown significantly, and now it requires a different attitude to this issue.

According to the authors the size of the plumbing cab should go according to the same evolutionary component as the living rooms go. Regardless of the category (elite housing or economy class) the area should be increased. Moreover, it is understood that the sanitary cab should satisfy not only the need for sanitary-hygienic procedures. It also should be able to place various simulators for relaxation in water and training (for example, baths for a water bicycle). Thus, the plumbing cab can become a health cell in the apartment of any consumer who is interested in maintaining his physical condition. This concept can be used for elite housing smoothly implementing these ideas in business houses and economy class.

The authors suggest to design of emergency ladders (dry water shutters) in all new plumbing cabins (both in new constructed buildings and in reconstructed rooms). It can help us to receive drains in the event of an unforeseen leak (this can also be done in the kitchen). Existing leakage control systems perform their work well, so water is blocked for 3-5 seconds in the event of an accident. However, their installation is not regulated by anyone and is not prescribed in any literature, that does not oblige the apartment living to install them. Flooding neighbors from the bottom can lead to sad consequences (damage to equipment, wetting and excessive moistening of building structures, etc.). It is advisable to mount several receiving holes in the floor at once and calculate them for emergency water intake in case of leakage.

It is more advisable to install the sanitary and technical cabin in the apartment and place it next to the future kitchen. This allows you to connect all the water distribution devices to one riser (cold water, sewage). Now there are different types of layouts, where the kitchen is at a considerable distance from the plumbing cabin and they are connected to different risers. This leads to overspending of the material and increases the cost of the entire plumbing and sewerage system. Also the consumer will have to install several meters at once for the apartment. In most cases this is due to the lack of the concept of "resource-saving design", and not only in the minds of architects, but of civil engineers too.

In accordance with the rules for calculating the plumbing system the length of the pipelines must be the least - the head losses are reduced along the length, it is advisable to make as few turns in the system as possible and the head loss to local resistance is reduced. Therefore, all the water-separating devices within the apartment are built on one wall (without pipe turns). Since the entry into the building is done in the part where a large number of devices are concentrated, on each floor it will be rational to arrange kitchens and sanitary cabins in the apartments as close to each other as possible. Thus, it is necessary to ensure that the head loss is minimal, that can influence on the future pumping equipment selection. As an example, we can consider two cases of layout decisions of plumbing cabins and water supply systems before the renovation and after redevelopment. It will allow making the most objective conclusions.

3. Results
Figure 1 shows the planning and tracing of cold water supply systems in the house before the renovation (typical floor plan (figure, a) and the basement plan (figure 1, b)). You can see that the size of sanitary cabins does not satisfy the concept of comfort (it is advisable to increase them, it shows the standard dimensions). The kitchen is far from the plumbing cabin. Figure 2 shows the variant of redevelopment with modern trends. The space previously unused in one-room apartments is being converted in an additional room. Taking into account modern trends, we place kitchens next to sanitary cabins, removing the number of unnecessary risers in the system. We will compose all water feeders as close as possible to each other. Comparative data on the two possibilities (before and after reconstruction) are placed in Table 1.
Figure 1. The plan of the standard floor of the house (before reconstruction) with the risers and sanitary equipment (a) and the basement plan (b) with the placement of the pipeline network and risers.
Figure 2. The plan of the standard floor of the house (after reconstruction) with the placement of risers and sanitary equipment (a) and the basement plan (b) with the placement of the pipeline network and risers
Table 1. Comparative data on the two design options before and after reconstruction

| №  | Data                                                                 | Before reconstruction | After reconstruction |
|----|----------------------------------------------------------------------|-----------------------|----------------------|
| 1  | the length of the main plumbing in the basement                      | 35.2 m                | 15.2 m               |
|    | (without input and connections to risers)                           |                       |                      |
|    | the length of the entire                                           |                       |                      |
| 2  | water supply network in the basement                                | 88.7 m                | 35.6 m               |
| 3  | number of water risers                                             | 10 pieces             | 5 pieces             |
| 4  | number of serviced water handlers                                  | 20 pieces             | 20 pieces            |
|    | the possibility of increasing the useful area of plumbing cabins for creating health cells | No, standard area | yes, the possibility of installing additional water |
| 5  | loss of head on length                                             | —                     | 2.5 reduction of head loss |
| 6  | loss of pressure on local resistance                                | —                     | 2.5 reduction of pressure on local resistance more economical pumping |
| 7  | selection of new pumping equipment                                  | —                     | selection in comparison with the variant before reconstruction |
|    | Joint operation of the pump and water tank                          | no                    | the case of large water intakes during peak hours |
| 8  | internal sewage system                                             | —                     | Releases and pipelines number reduction, less installation time |

4. Discussion

Table 1 shows us that using a new method of reconstruction it is possible to save about 53 meters of pipelines (installation and materials), significantly reduce pressure losses compared with the version before reconstruction and also to select more economical pump. It will reduce the electricity cost.

In addition, it is advisable to perform several additional actions after the reconstruction. It is better to install special water-saving nozzles for each mixer [15] to reduce water losses in the reconstructed building. These devices are screwed onto any standard mixer instead of the default aerator. Water-saving nozzle has a metal rod in its design. The principle is that the user sets the desired temperature and head (turns the valve or lever). Then he presses the metal rod and water begins to flow from the device. To stop the flow of water you should repeatedly press the rod. Thus, it is wasted so much water as we needed (there is no time to adjust the temperature and pressure, the consumer immediately starts to consume water). In addition, there are also some models with water-saving nozzles and the timer on the market. The user independently adjusts the metal rod shut off the water supply (usually after 3 to 10 seconds). It is not difficult to create a mixer that will have such a water-saving nozzle.

By the way, it makes sense to use the SR 30.13330.2012 "Internal plumbing and sewerage of buildings" and non-contact faucets that are switched on when handing them. This new type of water-tapping devices is widely described in the following literature. However, today it costs not cheap, and there is a benefit only if it is installed on the washstand in the plumbing cabin. In the kitchen this device will create certain inconveniences when filling large containers (kettles, pans, etc.). Thus, the water savings will be similar to the water-saving nozzles described above [16-18].

What about the pipelines selection for plumbing systems, it is allowed to use the following types of pipes: copper, bronze, brass, steel (with internal and external protective coatings from corrosion),
polymer pipes (polyethylene, polypropylene, polybutene, etc.) in accordance with SR 30.13330.2012 "Internal plumbing and sewerage of buildings" and its updated version 2.04.01-85 *.

The copper pipes use is currently relevant today[19-20]. In foreign countries they have found wide application due to their reliability (for example, in high-rise construction) in comparison with steel pipelines. However, their high cost will not be acceptable to the customer who wants to save money.

Choosing polymeric pipelines it is necessary to look at such parameters as operating conditions, service life, temperature of transported liquid, low roughness coefficient, etc. Preferences should be given to polymers with high durability indicators such as polybutene pipes. They have good flexibility, high resistance to cracking, good chemical resistance, high resistance and mechanical abrasion. Such pipelines are easily welded and also connected by means of press and threaded fittings.

5. Conclusions
Based on the foregoing we can draw the following conclusions:
- classic method of reconstruction (replacement just all of the systems with new ones without redevelopment) reduces the quality of living in the building and leads to an increase of capital expenditures;
- a new methodology of reconstruction system of plumbing and sewerage was developed, which allows to significantly reduce capital costs;
- redevelopment during reconstruction allows to increase the area of sanitarily technical cabins up to modern requirements of comfortable habitation;
- with the new reconstruction system, the length of the water supply is reduced almost 2 times, as well as reduced pressure loss and installation costs, which makes it possible to select more economical pumping equipment in comparison with option the variant before the reconstruction;
- there is a decrease in the number of releases and length of pipelines for the internal sewerage system and during the reconstruction of the new system and, accordingly, a reduction in the capital installation costs$ - the use of new polymer pipelines will extend the service life of the water supply till main repairs.

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