Replacing Electrical Wiring in Large-Panel Buildings

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Abstract. The article is devoted to complex solution of repair difficulties facing owners of apartments in old bearing-wall buildings. The example of the series 1-464A presents the experience of repairing apartments with the use of modern materials and technologies. On the basis of theoretical analysis of the range of problems in question the principal stages of repairing an apartment in a bearing-wall building are examined with total electric wiring replacement to improve the performance of the dwelling. The main technological operations are described; the features of the use of electrical components and finishing materials are given.

1. Introduction

In each apartment comes a time when tenants need a thorough repair, not mere wallpaper replacement. Domestic electrical wiring, which was carried out by aluminum wires several decades ago, needs to be replaced. Its insulation has aged, and the cross-section of wires is not enough to connect powerful modern household appliances. The ends of the wires are easily broken and set on fire.

Comfortable living in a renovated apartment is largely determined by the engineering equipment that will be available to residents during subsequent operation. The owners of the apartment can perform repairs both on their own and hiring specialists. It is important for the customer to know what result can be obtained at the present stage of construction technology and electrical work development. Owners should determine what electrical appliances they are going to use, how the sockets and fixtures will be located relative to the furniture.

[1] notes that in wall panels the replacement of electrical wiring in the channels is practically impossible. Nevertheless, it is possible, but labor costs are great. Sometimes you need creativity and a willingness to make specific solutions based on knowledge of both old and modern materials, technologies and design solutions.

The purpose of this work is to analyze the main stages of renovating the apartment in the panel house, to present practical experience of the authors on complete replacement of electrical wiring and improving the operational properties of the dwelling.

2. Preparatory works

The internal plastering during construction was most often performed with lime and sand mortar. Since the construction time (about 50 years) the plaster cracked, partially delaminated. Lime compounds, acting as a loose separating layer, prevent cohesion of new materials with the surface of reinforced concrete panels. When tenants begin repairs with the complete removal of old plaster, the
question of choosing finishing materials arises. As a rule, in old apartment houses panels lean from verticality and flatness. Tenants often choose to smooth walls with gypsum plasters Rothband or Volma layer. It is reasonable to preliminarily completely clear the surface of the reinforced concrete panel from lime mortar with special scraper knives. Dust work should be done in a respirator close to the surface of the face, such as a 3M 7500 silicone semi-mask with HEPA 2135 anti-dust filters.

After clearing, the concrete surface of the panels and slabs of the ceiling should be treated with acrylic primer. The surface coating is performed by TERRACO Handycoat for internal work. The putty is polished by hand or by a vibrating polishing machine. It is preferable to use grinding nets because they are less clogged with grinding dust. It is preferable to choose polishing machine for the ceiling with a small mass, as it has to be held on outstretched hands above the head (after polishing the ceiling is painted with water-dispersal paint, and the walls can be pasted with wallpaper).

3. Necessity and terms of replacing the old electric wiring
In accordance with Part 1 art. 25 of The Housing Code of the Russian Federation the reconstruction of a residential space is the installation, replacement or transfer of engineering networks, sanitary, electrical or other equipment requiring the introduction into the technical passport of a residential space. If there is no wiring scheme in the technical passport for the apartment, then its change is not regulated by the housing code. Currently, with the capacity of personal consumption of 15 kW or less projects per apartment are not required.

Starting with 2001 according to Electrical installation rules 7.1.34, cables and wires with copper cores should be used in buildings [2]. It is necessary to lay a triple cable, but the PE-conductor (grounding in the sockets) is temporarily not connected. When in the future, during the overhaul, the electrical stand of the building will be performed on a five-wire scheme and instead of one PEN two separate main conductors PE and N will be laid.

Wiring to sockets in houses built 20 or more years ago was usually carried out by an aluminum wire with section of 2.5 mm². This does not allow it to be used to feed powerful modern household appliances. During operation ageing of wire insulation occurred. Resistance of insulation, which sometimes cracks, has decreased, creating conditions for current leakage, breakdown and short circuit.

When clearing the panels, you need to find all the distribution boxes. The channels in the walls run the shortest route from socket slots and switches in the walls to the branch boxes under the ceiling. They look like through semicircular cavities on upper and lower edges of wall panels (fig. 1). There all cable-channels from sockets in the walls and from holes for chandeliers in floor slabs meet. In series 1-464A, they are in the middle of the walls under the ceiling or above the switches [3], and are often filled with mortar.

![Figure 1. Stretch cavities in reinforced concrete panels.](image-url)

If the owners of the apartment live in it during the renovation, the work is done room after room. After the power shutoff, the boxes are gently cleared of the old mortar. It is important to prevent small pieces of plaster from entering the wire channels. Particular accuracy should be shown in the separation wall panels. Neighbors often want to keep their wiring unchanged for various reasons. In this case, any careless movement can create a through hole to the neighbors or damage their wiring.
4. Electric wiring laying techniques
There are several ways of laying electric wiring.

Hidden wiring in residential areas is located: behind hung/counter ceilings; in the voids of ceiling slabs; on the walls (under plaster, in cable channels); in the floor covering (should be in the flute or tubing); in the voids of flooring.

Open wiring in residential areas is carried out: in plastic/metal cable channels (there are different colors); technological skirt boards (producers offer built-in electrical installations to them); insulators (retro).

In the apartment it is possible to overhaul the leading-in cable and all the wiring, making the most of the existing old channels.

Some channels may be narrowed or impassable: there can be construction waste from neighbors, large nonremovable pieces of concrete, etc.

A makeshift device (fig. 2) can crush a small pebble inside the cable-channel, preventing the pulling of the new cable. Two thin cables are tied to both ends and passed through the cable channel.

![Figure 2. The tool for clearing cable-channels: outer diameter is 19 mm, total length is 60 mm, diameter and length of the hole is 10 mm, diameter of the hole is 5 mm.]

It is necessary to be prepared for the need to correct the laying scheme and number of cables.

5. Temporary and permanent domestic branching boxes
The floor box must be completely overhauled with the involvement of an electrician from the management company, who has the right to seal the meters. In the floor box remain a tap from the stands with solid copper wire PV-1 section 6 mm², lead-in double pole circuit-breaker (AB) at 32-40 A, electricity supply meter. Three wires with the section of 10 mm² enter the apartment: mass, neutral and protective conductor PE. Usually it is recommended to make lead-in with a flexible wire PV-3 (PuHV) or triple conductor VHG 3x10. Lead-in cable can sometimes be let through the cable-channel for low-current consumers.

In residential areas, it is necessary to use a low-smoke cable with copper wires only with the ng-LS index (e.g., HVG ng-p-LS). The diameter of the cable channel according the project is 20 mm (or 25 mm), but in practice there are also narrower places. It is better to use flat VHГ. In our practice, we managed to extend 4 flat VHГ 3x2.5 and one 3x1.5 into cable channel. It was the most difficult place, so we spread out and leveled all the cables on the floor without twisting them and fixed them through 40-50 cm with two turns of PVC tape. When pulling the harness into the channel, the fixing tape was removed. It is advisable to remove concrete at the entrance and especially at the exit of the channel, giving the channel a smooth turn, so that the cables spread without sharp bends. New cables are pulled into channels with a draw rope (you can use a steel wire with a diameter of about 1.2 mm). The work is usually done together with an assistant: one handles and directs the cable assembly, the other pulls it with a draw wire.

Often for the construction period a temporary domestic branching box is installed (fig. 3). For temporary connections, it is convenient to apply a neutral bus to the DIN rail in the 4x11 group case. New modular circuit-breakers and Residual Current protective Device (RCD) is better installed after all the preparatory (dirty) work, as the reliability of these devices is greatly reduced due to the fact that their mechanical part is very sensitive to pollution with construction dust.
Figure 3. Temporary and permanent domestic boxes in a two-room apartment.

Into the apartment box for 24 (better 36) modules all the lines are connected, the number of which in the apartment is always individual [4-12].

A large number of cables cannot be laid in the channels along the old routes. A lot of help can be provided by blank channels not involved in construction, which significantly facilitate the laying of a large number of cables, especially towards the branching box. You can lay wiring in the joints between the slabs of the ceiling.

According to Electrical installation code 7, the laying of the wire in the indent is usually equated to laying in a pipe [2]. In determining the number of wires laid in a single pipe (or conductor strands), grounding and zero protective conductors are not taken into account. That is, for the copper wire 3x2.5 mm² (where the third thread is PE), laid in the pipe, the allowable current, according to the [2] is 27 A.

In order to improve the reliability and durability of electric wiring, as well as due to the fact that wire manufacturers often underrate the actual section of the wire (e.g. rating 2.5 mm², but in fact 2.1 mm²), it is customary to reduce by a degree the protective circuit-breaker rating relative to the table. For example, a 3x2.5 mm² conductor should be protected by a 16 A circuit-breaker. For the majority of residential solutions the following wire section – circuit-breaker rating ratio are optimal:

- 1.5 mm² – 10 (13) A – load up to 2.2 (2.8) kW;
- 2.5 mm² – 16 (20) A – load up to 3.5 (4.4) kW;
- 4.0 mm² – 25 (32) A – load up to 5.5 (7) kW;
- 6.0 mm² – 32 (40) A – load up to 7 (8.8) kW;
- 10.0 mm² – 50 A – load up to 11 kW.

The increase of AB rating compared to the recommended, but no more than permissible current, should only be in reasonable cases when fulfilling the following conditions: knowingly high-quality cable of non-underrated section, knowingly reliable cable connections that can withstand such a current load, the absence of "weak spots" in the line that can be overloaded with such an AB rating.

In order to improve electrical safety in the domestic branching box, a Residual Current protective Device (RCD) must be installed. To exclude false cutoffs due to natural leakage currents it is reasonable to use several RCDs, for example: the first RCD 30 ma for electric cooker + kitchen sockets; the second RCD 30 ma for room sockets; the third RCD 10 ma (for humid areas) – utility core, boiler, washer.

Lighting is allowed to be installed without the protection of the RCD.
6. Wire bonding
For home craftsmen, the most optimal recommended wire bonding is soldering. Twists of 5-6 cm long are soldered by a conventional 100 w soldering iron, using a solder of POS-61 and a flux (resin). It is rational to use solder with resin inside in the form of wire with diameter of about 1 mm (sold in coils).

Liner casting is the easier way. Needed: crimper for liner casting (can be PC-16 or PC-16 from KVT), GML-type liners of the required size (given the section and the number of conductors bonded) [13-15].

In both cases, the joint should be isolated by heat-shrink tubing, preferably with adhesive layer or two layers of good insulation tape.

Wago series 224 terminals are used to connect the chandeliers with copper wires.

After sealing the connections, the distribution boxes are covered with non-flammable fiberglass and thick sheets of paper-based laminate 3 mm thick, box-size cut.

7. Wall chasing and socket jacks
If the installation of additional sockets is necessary (fig. 4) jacks for them are carried out with percussion-rotary or diamond crowns with diameter of 68 mm for boxes with the diameter of 65-68 mm. The center-to-center distance for the sockets in the unit is 71 mm.

![Figure 4. Wiring installation in a metal pipe under the wooden floor towards additional sockets.](image)

It is desirable to chase in panel buildings as little as possible and only vertically. It is convenient to remove concrete between the saw cuts with tubular jumper by means of chopping-off hits holding the device at 30–45° angle to the surface.

A box of CL-5C is used in the kitchen to connect the cooktop. Since kitchen cabinets usually have table legs 10 cm high, sockets for the appliances (oven, dishwasher and washing machine) are placed so that the top edge of the socket with a frame is not higher than 10 cm from wearing floor level. There are legs of 15 cm - if you want to raise the tables higher. The sockets can be surface mounting (you can't see them at the bottom).

8. Conclusions
A significant improvement in the consumer qualities of a dwelling is possible only when replacing infrastructure, which, in the long run, allows taking advantage of all the benefits of modern household appliances. This work should be carried out before fine finishing, in compliance with all safety regulations and with accurate observance of work technique, as well as taking into account the guidelines presented.

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