Roofing Arrangement with Facing Roll Materials

S Sinenko¹, B Zhadanovskiy², L Pakhomova³
¹National Research Moscow State University of civil engineering" (NRU MSUCE), Yaroslavskoe shosse, 26, Moscow, Russia

Abstract. In the article it is recommended to utilize simple means of mechanization as well as to execute some operations manually, bearing in mind that for roofing arrangement one engages small enterprises participating in construction of low-rise buildings, their current and capital repairs on operated industrial and civil objects. Structure of technological operations: base and slopes flatness control from watersheds to drain funnels; surface defects elimination; contaminants removal. Herewith, it is recommended to use domestic and foreign tools and implements: hammer; boaster; chisel; steel brush; watering can; mortar blade; mortar supplying bucket; water and mortar dip-buckets; three-meter control rail; level; folding meter or tape measure; safety glasses. In the article, as a result, it is ascertained the rational methods of soft roofing arrangement (based on labor intensity measurements in labs) and gained optimal organizational and technological solutions allowing to carry out processes taking into account work safety for workers.

1. Introduction

The growth of housing construction implies wide distribution of methods for roofing arrangements with different materials, by using simple and complex technological methods, means of mechanization.

In Russian Federation it is widely utilized various methods and techniques of roofing arrangement. These methods and techniques have been studied, it has been obtained optimal technological processes [1,2,3,4,5,6,7,8,9,10].

Flow sheets and flowsheets of operational sequence practically for all types of roofing arrangement are developed. It is important to utilize simple means of mechanization as well as to execute some operations manually, bearing in mind that for roofing arrangement one engages small enterprises participating in construction of low-rise buildings, their current and capital repairs on operated industrial and civil objects.

An objective of the article is design and offer simplified roofing arrangement techniques with facing roll materials. The objective is being reached through solving a number of issues. Meaning technological operations designing such as base and slopes flatness control from watersheds to drain funnels; surface defects elimination; contaminants removal.

It is recommended to use domestic and foreign tools and implements: hammer; boaster; chisel; steel brush; watering can; mortar blade; mortar supplying bucket; water and mortar dip-buckets; three-meter control rail; level; folding meter or tape measure; safety glasses. Besides the most matching materials for roofing arrangement is also recommended. Materials: cement-sand mortar with grade not lower than 100, site-prepared, asphalt concrete.
2. Methods

Sequence of technological operations. One commences operating after arrangement of levelcrete is finished. It is controlled slopes of a base and its evenness. After construction contaminants removal the base surface is being checked with three-meter control rail being moved in longitudinal and transverse directions. A clearance in between the rail and the surface should not exceed 5 mm. Surface defects such as ledges, cavities, etc. is marked with a chalk. Cavities, cracks, gaps between laid roofing slabs, as well as places of their adjunction to walls are cleared of a dust, moistened with water and closed up with a cement mortal by blade. Bulges, sags of stiffened mortar are cut down with boaster or chisel.

It is allowed not more than 5 mm clearance between a three-meter control rail and the base surface at the areas of defect removal. Spaces at the zone of roofing adjunction to walls must be very carefully plugged with 100 grade mortar not less. The surface should be clean and dustless.

Base priming. Before starting work one should finish all roof construction work, mount internal drains and install drain funnels bowls, arrange levelcrete, temperature-shrinkage joints and expansion gaps, repair potholes and sinks, plaster vertical surface sections of structure (walls, ventilation pipes, etc.) at the height of roof contiguity. The transition locations from horizontal surfaces to vertical ones should be performed by fillet with a radius of 100 mm of cement-sand mortar or asphalt concrete. One should dry the base with compressed air, check the operation of roof installation compressor, check hoses, connections and nozzles.

Composition of technological operations: hoses bringing up and application of priming compound.

Mechanisms, tools, devices, equipment: machine PKU-35, priming unit AO-1M or similar, brushes, rollers.

Materials: bitumen BN-70/30; upgraded kerosene; white spirit.

Workplace organization. The priming compound supply installation is set near being constructed building (Fig. 1). Roofers – a unit of two people – take their places. The levelcrete surface is primed by strips with a width of 4-5 m.

![Figure 1. Works organization scheme](image)

Sequence of technological operations. The roofer, being in the workplace at the division edge, signals to installation operator to supply primer. For priming roofers occupy the following position: one holds the nozzle, the second holds the sleeves. The compressor operator opens compressed air supply valve to the primer tank and to the gun, as well as primer supply valve to supply gun. Then the roofer opens air and primer supply valves on the gun and adjusts a spray torch. With the nozzle roofer applies primer on base surface by circular movements, preventing the formation of puddles, zigzagging moving back. One applies primer with a layer of 0.5-0.6 mm thick by moving the gun
towards itself, holding the nozzle at a distance of 40-60 cm from the primed surface at an angle of 60-65 degrees, moving across the span of the roof from the leeward side. The second roofer brings the sleeves up, and the operator monitors operation of the installation at this time. The primer layer should be solid, smooth, without gaps, which is determined by visual observation of a foreman.

Pasting funnels of internal drainage. Before starting one needs: to install internal drainage funnels; to clean them from rust and coat them with anti-corrosion composition; to deliver to workplace rolled materials in rewound and cleaned condition; to clean and prime base; to deliver to workplace tools, fixtures and equipment.

Composition of technological operations: fiberglass cutting and fitting; mastic applying; fiberglass sticking up on the funnel bowl and around it; fiberglass sticking on the wall of the funnel socket; facing roll material cutting and fitting; facing roll material sticking; sticking of the two subsequent layers of facing roll material.

Mechanisms, tools, fixtures, equipment: mastic tank with cart for transportation; roofing brush for leveling mastics; knife for cutting roll materials and fiberglass; wood pattern (70x25x1000 mm) for fiberglass and roll materials marking.

Materials: fiberglass, mastic MBK-G-85, facing roll material.

Workplace organization. Upon the roof area, where the drain funnel is located, it is required one roofer engaged. One locates at the area a roll of fiberglass, mastic tank, a roll of facing material. Having unfolded a roll of fiberglass on 2,2-2,5 m, the roofer measures out with template a 1 m piece, having bent fiberglass on a mark, by moving a knife from itself (across a roll) cuts off in a bend place. Then he fits a cut piece of fiberglass in place, overlapping funnel socket and adjoining part of the base. Mastic is delivered to workplace in tanks. Without fiberglass moving, the roofer bends up half of the piece and with brush moving up and down applies the mastic on the funnel bell, and moving to the right and left covers the area around the funnel with mastic. Similarly, the mastic is applied to the second half of fiberglass. Then one lays down the unbent part of fiberglass upon greased with mastic surface and presses it with gloved hands, smoothing out the funnel hole to edges. The same way one pastes fiberglass on the second half of a bowl, pressing it on a contour. After gluing with a knife a cross-shaped incision is made in the center of a funnel, bending the formed corners down and tightly pressing them with gloved hands to the wall of the funnel bell. Then the roofer unfolds a roll of facing material on 1,5-2 m and, having measured out with template a piece of required length, cuts off it with a knife, fits and puts this piece on a funnel and the part of the basis adjoining to it. Then he bends up a half of the piece and faces it with a torch. The second half of the funnel is faced the same way. The final processing of the funnel is that the worker makes a knife cross-shaped incision in the center of the funnel, bends down the formed corners of facing roll material and tightly presses them with gloved hands to the wall of the funnel bell, pasted with fiberglass. All being pasted pieces of fiberglass and facing roll material must be intact, without defects, without tears. There should be no delaminations in the edges of the glued pieces of fiberglass and facing roll material, as well as in the places of sticking on the wall of the funnel bell.

Roofing arrangement with facing roll materials by cover layer heating. Before starting works it is required: to carry out vapor barrier, insulation, to arrange and prime levelcrete, to install and secure the drain funnels, to prepare and install in the area of roofers working mechanisms, equipment, fixtures and means of safe work.

Composition of technological operations. The group consists of three people. Roofers take from stacks the rolls, stack them to fit, measure, cut if necessary, lay them down along the front of works, taking into account the overlap width, then the rolls are rolled back. Roofers, having placed the cloth end to the surface of sticking start, unfold roll on 3 m, align the cloth in parallel to the roll taking into account set overlap. Then one roofer puts a compactor up on the rolled section of the roll, orients it in moving direction, the second roofer inserts the axis of compactor into the roll and puts on limiting washer. Both roofers install the axis with the roll at compactor, and the third roofer prepares a burner to work.
Mechanisms, tools, fixtures, equipment: gas or liquid burners for facing materials by cover layer heating, unroller for roll materials, sleeve for fuel B-ZS9 (10 m), container for rolled materials or the pallet PS-0.5L, electric reversible winch (with a metal console) or roof crane K-1, K-320, K-1M or KBK-2, cart for transportation of rolled materials, compactor for rolling-on IR-835 or similar, knife for rolled materials cutting (if necessary), stroke with rubber insert for smoothing seams in overlap places, compressor, gas cylinder, tank with kerosene, sandbox and fire extinguisher.

Materials: bikrost (technical specification 21-00288739-42-93), bikroplast (technical specification 5774-001-00287852-96), bikroelast (technical specification 5770-541-002284718-94), izoplast (technical specification 5770-002-0056235-94) and other similar materials.

Workplace organization. On division’s boundary site one equips a platform, the pallet for reception and storing rolled material is arranged. Roofer roll out in parallel 4-5 rolls of facing material on 2-3 m in pasting direction. Having set overlap width, the rolls are rolled back. When roof slope is less than 5% the overlap in all layers should be not less than 100 mm in length and width of cloth; with a slope of more than 5% in the lower layers – not less than 70 mm, and in the upper layer is not less than 100 mm. In all layers overlap panels should coincide with roof slope direction. The first roofer sets the nozzle to melt the mastic layer so that the heat flow is evenly distributed over the entire width of the roll. As soon as a roll of mastic appears in front of the roll, formed by melting mastic upon the roll and the bitumen film on the base, the second roofer begins rolling out the roll. One pastes rolled carpet of facing material, heating it with open flame with a nozzle. At roof slope coming up to 15% facing roll material is pasted, positioning cloths perpendicular to main drainage, and if slopes are over 15% in parallel. The third roofer, following the first two, rolls down the pasted material with compactor. Workplace organization is shown in Fig 2.

![Figure 2. Workplace organization scheme: 1 – melting unit; 2 – roller-compactor; 3 – manual burner; 4 – diesel tank; 5 – compressor; 6 – manual cart; 7 – container; 8 – crane K-1 (KPK-2); 9 – ramp; 10 – sandbox and fire extinguisher.](image)

Sequence of technological operations. The 5th category roofer works with a gas or liquid burner. The 3d category roofer unrolls each roll on site to clarify direction and overlap, rolls up the cloth back into a roll, runs a spindle into roll inner hole and pastes the cloth end to the base with burner. The 4th
category roofer sets the roll with spindle to roller-compactor and rolls it out. While pasting, he monitors the correct direction of rolling and roll lapping. The 2d category roofer brings rolls up on cart to work site, helps the 3d category roofer to fit and paste the ends of fitted cloth to the base using a hand burner. The 4th category roofer moves, directing nozzle flame at a certain angle to being pasted roll. Meanwhile mastic is evenly melted across the entire roll width. As mastic being melted, the 3d category roofer moves the roll forward, sticking it to roof surface. The second roofer of 3rd category carefully smoothes a stroke of pasted roll edge. For pasting roof covering in remote areas – near funnels, ends, junctions - one uses the same manual burners on gas propane-butane.

When melting cover layer, it is necessary to control preventing formation of bubbles on the upper side of facing cloth. The adhesion strength to the base is checked by slow separation of roll cloth from the base. The break should occur on roll cloth.

Roofing arrangement with facing roll materials without heating by using spray gun. Before starting works it is required: to install and fix drain funnels; to complete levelcrete and transition skirtings arrangement in full; to prime levelcrete; to prepare and install on work site mechanisms, equipment, fixtures and means for safe operation.

Composition of technological operations: positioning and rolling out the rolls; pasting rolls with roller-compactor and spray gun.

Mechanisms, tools, fixtures, equipment: roller-compactor, spray with a gun or installation of CO-21A, paint rollers, universal cart for rolls and barrels with solvent transportations, compressor CO-7, container for roll materials KZ-1G, knife for cutting roll materials, metal tape measure, folding meter, sandbox of 0.5 m³, shovels, asbestos cloth – 3 m².

Materials: facing roll materials; white spirit (GOST 3134-78), lighting kerosene (OST 38.01407-86), technical kerosene (GOST 18499-73) (any of mentioned).

Sequence of technological operations. Roofers lay facing material rolls along the front line of work, install roller-compactor and charge a roll as follows: put roller-compactor upon unrolled portion of roll, orienting it in the direction of movement, insert compactor axis into a roll, put a limiting washer, install axis with the roll on the roller of compactor and begin to paste the roll. Roofer applies solvent on roll and base, enabling solvent supply valve on a gun. After pasting one roll, both roofers move to the next unfolded roll and repeat the operation of pasting. The applied solvent amount is 45-60 g/m² of surface. In 7-15 minutes the third member of working group put compactor upon the first pasted roll and rolls it down. The compacting process proceeds continuously, sequentially moving from compacted roll to just pasted one. It is necessary to compact each roll three times for strong cloths pasting with the basis and with each other. Transportation of rolls and solvent barrels is carried out with universal cart.

The quality of roofing materials must meet the requirements of existing GOST and TU. The adhesion strength of facing roll material to the base is checked by slow separating of cloth from base. The grip must be strong and the break must be consistent with designed one. Solvent application should be even over the entire surface of base, which is set visually.

Labour, fire and environmental safety. At base cleaning process the movement of workers performing garbage cleaning and dust removal by means of compressed air is to be made in the direction opposite to wind direction taking into account the scheme of workplace organization.

Protection of respiratory tract from dust at the stage of garbage collection and lowering the chute into the receiving hopper. The workers performing the specified operations are to be provided with working cloths and protective masks.

While removing base unevenness with manual tools (crowbar, boaster, chisel), worker should use protective glasses, protective mask and gloves. Places of roofing works production must be fenced; at work “at height” the worker must operate in helmet with safety strap.

While executing roofing works in the safe way it is necessary to fulfill requirements of GOST [17, 10, 11, 13, 14] and SNiP [15,16,17,18, 19, 20], and also the requirements stated below. Only workers qualified to safe methods of work are allowed to roof arrangement works.
Persons not younger than 18 years who have passed medical examination, special theoretical and practical training on the existing programs, passed examinations and received the certificate are allowed to roofing works with use of solvents. The solvent amount at work site should not exceed the replacement rate (70-80 liters). Solvents are toxic, volatile, flammable substances, therefore it is prohibited to store and carry them in open containers.

Solvents in barrels should be stored at the distance of 20m from building, protected from direct sunlight. One is allowed to store not more than 5 barrels at one location. UnscREW the plugs from the barrels (even empty) is allowed only with a special wrench, without hammer and chisel. Empty solvent barrels should be sealed and stored in a designated area away from work in accordance with applicable fire regulations. It is prohibited to solder, to cut and weld metal barrels for solvent until its cleaning and degreasing.

For skin cleaning from bitumen, one should use “Rakhmanov paste” and soap produced by Moscow research Institute of hygiene and sanitation by F. F. Erisman or analogues. It is forbidden to apply for skin clearing from bitumen any solvents, which can cause skin irritation and disease.

It is forbidden to smoke while roofing. At working place on should post posters “Smoking is strictly prohibited on the entire roof!”.

The work place should be provided with primary means of fire extinguishing (fire extinguishers, shovels, sand, buckets, hooks, etc.) in accordance with GOST [19, 5, 6].

3. Outcome and discussion
As an outcome of this article, rational methods of soft roofing arrangement were clarified (based on the measurements of labor intensity obtained in the laboratory) and optimal organizational and technological solutions were obtained, allowing operating in respect to safety of workers.

4. Conclusions
This article is innovative, because it is the most fully represented technology and organization of roofing works production with facing materials. In addition, the advantage of this article is translation into English.

Based on certain types of technological operations analysis one concluded necessity to reduce manual tools usage while roofing. The authors propose moving mainly towards mechanized labour in the future. In addition, it was found that in the future it is necessary to expand the type range of soft facing materials while residential and industrial buildings and structures constructing and reconstructing. The obtained conclusions and recommendations are intended for specialists designing organizational and technological documentation including technological maps, projects of works, regulations and codes of practice.

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