Saimaa University of Applied Sciences
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Civil Engineering

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INNOVATIVE METHODS OF CONSTRUCTION BASED ON EXPERIENCE OF NCC CONSTRUCTION

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ABSTRACT
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The purpose of the thesis was to investigate the innovative ways of construction according to experience of NCC Construction (Russia). The object of studying was residential complex Swedish Krona in Saint-Petersburg. This project is well-known because of ecologically-oriented engineering systems, providing new level of comfortable life for NCC's clients. The most important system is heat recovery system, which gives the possibility to control air exchange inside the flat, heat consumption and collect unnecessary energy for heating of coming air. This system was studied and explained in the fourth chapter. NCC also uses special equipment called Elpo panels in their construction sites. It consists of all necessary ducts and pipes for engineering systems installed in one reinforced concrete block. These panels, imported from Finland, permit to save the time of construction and project works, reduce cost and make the process of management easier. Installation and working principles are presented in the third chapter. Now NCC is searching for new ways of production sanitary equipment. The task was to find possible suppliers in Russia or in neighborhood countries. The results and producers were discussed in the fifth chapter. Economic analysis and calculation of two variants – Finnish and Chinese suppliers were discussed in the sixth chapter.

Keywords: recovery system, Elpo elements, sanitary equipment, green construction

CONTENTS

1. INTRODUCTION

The idea of this thesis is based on new ways and techniques in construction in Saint-Petersburg, Russia. It is definitely hard to create something new in construction systems or technologies, but there is an empty field of actions in engineering services, that improve the level and quality of life. One of such companies in Saint-Petersburg market that develops and implements new methods and schemes of engineering supply is NCC Construction. NCC company is well-known all over the world, it has branches in Scandinavian countries, Baltic countries, Germany and Russia. The Saint-Petersburg office was opened in 2008. Now this company develops 2 main projects – residential complex “Swedish Krona” and “Öland”. Swedish Krona construction site consists of 5 construction stages, 2 of them are already occupied by clients (see Figure 1.1). Each stage consists of from 2 to 5 buildings. There are three buildings with 14 floors, and 9 buildings with 9 floors (See Appendix 1). There are loadbearing longitudinal-and cross walls. The buildings are made of monolith concrete mostly; partitions are made of gypsum boards; outside walls could be monolith or filled by gas concrete. There are from 6 to 8 flats on each floor. The first floor is suited for commercial offices and technical services. The residential complex contains the parking module also among buildings of 2^{nd} - 5^{th} stages, it is half-deepened. There are some two-level flats and top-floor flats with own terrace on the roof. NCC also provides inside finishing – for example settlement of all sanitary equipment, finishing of all inside surfaces and floor structures completion (with parquet, laminate or ceramic tiles). But mostly flats are handed over with so-called “white” finishing: the walls are straightened with plaster and covered with white paintings, water insulation is made in WC-rooms and bathrooms, floors are also straightened with cement-polymeric topping mixture.

The NCC contribution to the ecology and environment protection is the implementation of heat recovery system. This system was developed and used by NCC for the first time in Saint-Petersburg. The heat recovery system helps to reduce the quantity of heat that is used for flats heating. This system could take away the excess heat from a cooker hood and inside air and make the supply air warmer. The efficiency of that process is quite high.

The other innovative technology used by NCC construction is using of Elpo elements. Elpo is quite useful and well-known in Finland and in other Scandinavian countries, but they were used in Saint-Petersburg for the first time about 5 years ago by Finnish company YIT. Now the experience of use was taken by NCC and implemented during Swedish Krona construction. NCC orders these elements from Finland now, but the price of production and delivery is quite high, that is why the company is under searching of new suppliers. Elpo panels for NCC construction include the pipes for waste water, water supply and air ducts. Elpo elements provide shortening of construction time, spaces economy and proper sound insulation during the lifetime of engineering services. Now NCC is searching for new ways to make the construction process faster. One possible solution is to use prefabricated ready-to-use sanitary cabins. There are a lot of advantages in doing this: time economy, simplification of installation, more decorative decision. Historical research about the USSR experience in that case, possible suppliers and NCC perspectives in use are presented in the 5th chapter of the thesis.

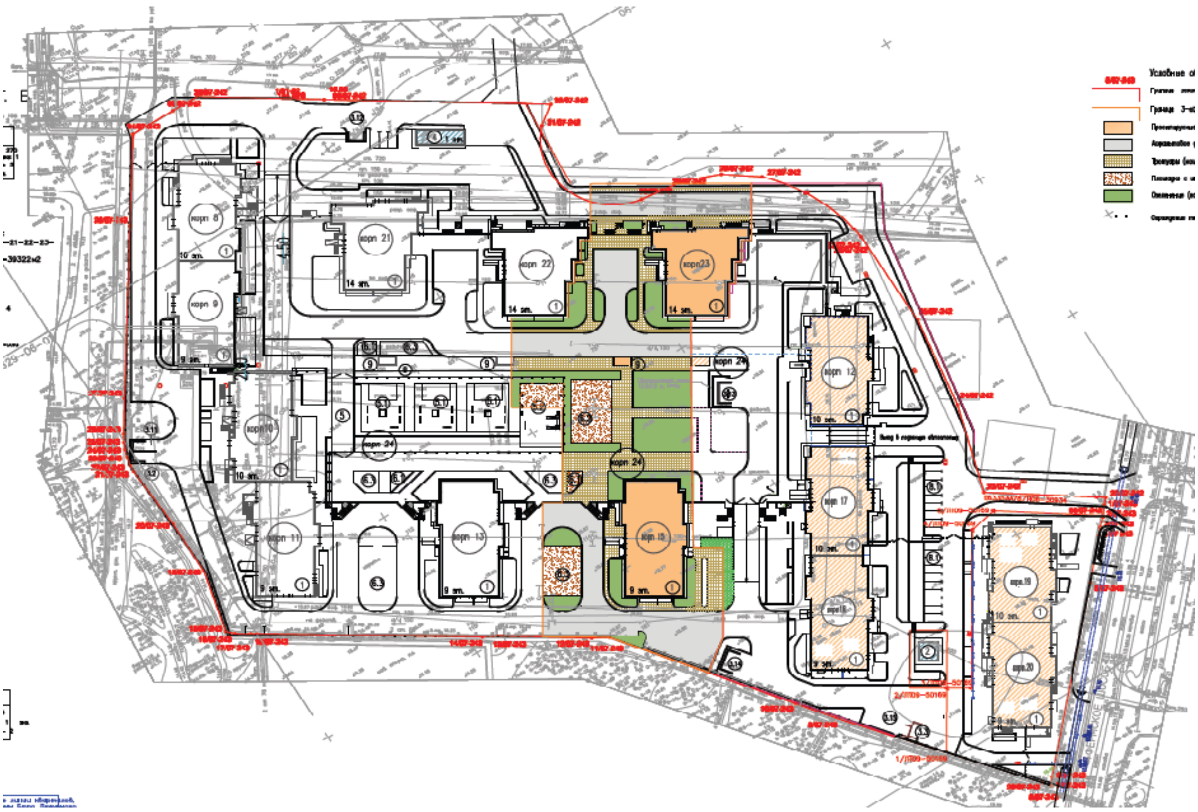


Figure 1.1 Fragment of Swedish Krona general plan

2. EVOLUTION OF THE VENTILATION SYSTEMS DURING THE PAST 50 YEARS

There are a lot of possibilities to provide ventilation in the building. All ventilation systems are classified by the type of air movement – with natural or mechanical motive; the purpose – blowing or exhaust system; zone of production – local and common. The most popular way in Russia is natural ventilation without any special exhausting equipment. This method was used for hundreds of years all around the world. In such systems air blows through holes and imperfections of window frames and other structures, special tubes and shafts act as exhausted systems in WC-rooms and kitchens. The reality is that the natural infiltration of air is not a reliable source of adequate amounts of air to maintain good air quality. (Gord Cooke, 2005)

But nowadays the natural ventilation system has become ineffective and old. Contemporary norms and regulations demand to use mechanical ventilation with forced exhaust and blowing. Table 2.1 shows the positive and negative sides of both ventilation types.

Table 2.1 Comparison of natural and mechanical forced ventilation system

Type	Advantages	Disadvantages
Natural ventilation	Low cost of mounting and service	Low quality of air – without purification, dehumidification, gas control. Works only in winter, when atmospheric pressure differs so much
	Typical structures	Difficult to control air flows and volumes of changed air
	Simple to produce	Blowing and exhausting could be unbalanced

Mechanical forced ventilation	Pure and quality air inside, easy to clean	High energy consumption
	No health damages, allergy. Comfortable condition for consumers	High cost of mounting and service
	Large variety of products and ways of making forced ventilation.	Need additional space for placement

The important technological advance that made mechanical ventilation possible was the development of the electric power industry. But even then, mechanical ventilation was slow to catch on. If you look at buildings constructed in the early part of the 20th century you will notice that most floor plans are generally variations of narrow rectangular areas with the distance from one exterior wall to the opposite exterior wall not more than about 50 feet. Even the very largest buildings were arranged with H-shaped, T-shaped, or U-shaped floor plans. The reason was to keep all the building occupants within reasonable distance to a window for both ventilation and light.

During World War II, ventilation became an important issue. Buildings and factories operating at night during the war had to do so under blackout conditions. Manufacturing facilities for war production were often erected without windows, forcing engineers to consider mechanical ventilation as a source of fresh air and temperature control. Generally, air was provided in sufficient volume to keep the average interior air temperature at about 10ºF (5.6ºC) above the outdoor air temperature. (Carrier Corporation, 2001)

The main components of forced ventilation system are ventilators, engines, air heaters and air coolers, filters, etc. All together they produce the change of air inside the room. The purpose of forced ventilation is to approach the inside microclimate conditions to the natural climate conditions. There are some bad cases concerning people's health when natural ventilation is not enough or forced mechanical ventilation is missing:

1. Pollutant dirt such as carbon dioxide, ammonia, methane, aldehydes that could be founded in the air, concentrations could be dangerous. Some of these pollutants are produced by people breathing, but some could be evaporated by furniture, construction materials and clothes.
2. A lot of gas components as water vapour that could cause breathing problems.
3. Bad health condition: languor, sleepiness, headache, loss of workability.
4. Reason of chronic ailments and allergy.

With current building practices it is vital to remember "to build tight and ventilate right". The elements of good mechanical ventilation overcome the shortfalls of natural infiltration. The key concepts are:

1. The right amount of ventilation on a constant basis. This has been a code requirement for at least 15 years.
2. Exhaust from wet areas such as bathrooms and kitchens
3. Provide fresh air distribution to bedrooms and main living areas. (Gord Cooke, 2005)

There are three main types of forced ventilation systems: blowing, exhaust and blowing-exhaust ventilation.

2.1 Blowing ventilation

Blowing ventilation provides sufficient inflow of the air to the inside spaces of the building. Used air moving away happens by means of window holes and by open doors (excess pressure). The main element of blowing system is a ventilator with electrical engine that pumps air. When necessary, entering air could be subject to special treatment – heating, filtering or moistening. All equipment for air treatment is placed in the blowing camera near air intake. When necessary, noise protection systems could be installed. Blowing plants could be equipped with automation systems because high level of accuracy is demanded.

2.2 Exhaust ventilation

Exhaust ventilation provides removing of used and polluted air from the space. This system provides so-called under pressured houses. It is also actual for water vapour removal. This system is widespread in industrial buildings, where water vapour and heated air are generated during the production process. In huge public places, swimming pools and ice halls exhaust systems are also popular because of their possibility to take out big amount of water vapour. Exhaust systems are simpler than blowing systems. They consist of an exhaust ventilator and an electric engine, when the system of spaces is difficult, big or takes a lot of space, airways take air out from a building to the outside by windows and open holes . When the air is polluted so much, filters are useful.

2.3 Blowing-exhaust ventilation

Blowing-exhaust ventilation provides supplying fresh air and moving away dirty air at the same time. Two main principles of blowing – exhaust ventilation are used. The first one is agitation when the fresh air is coming inside by means of high-speed diffusers. Fresh air is mixing with the inside air of the space. Used air goes out through exhaust valves. The second one is displacement of used air by fresh air. Fresh air comes from the lower parts of the room, warm used air goes up and moves out. This way is useful in industrial buildings and high – ceiling buildings.

2.4 Contemporary situation in ventilation services in some EU countries

Ventilation system is a combination of appliances designed to supply interior spaces with outdoor air and to extract polluted indoor air. The system can consist of mechanical components (e.g. combination of air handling unit, ducts and terminal units). Ventilation system can also refer to natural ventilation systems making use of temperature differences and wind with facade grills in combination with mechanical exhaust (e.g. in corridors, toilets etc.). Both mechanical and natural ventilation can be combined with operable windows. A combination of mechanical and non-mechanical components is possible (hybrid systems).

Across EU countries, ventilation does not follow the same practices. This discrepancy can be due to the climate and building tradition. For the future development of energy efficient ventilation for good indoor environment it is important to know the ventilation systems in current building stock in Europe. In this summary commonly used ventilation systems in Europe in dwellings, schools, kindergartens and office buildings. The ventilation systems are either natural or mechanical ventilation. (Andrei Litiu, 2012)

Figure 2.1 describes different types of ventilation and its classification. Numerical and alphabetic information facilitate further explanation. There is a red box around the most progressive type of ventilation systems – with heat recovery. The detailed explanation and possibilities of use can be seen in chapter 3.

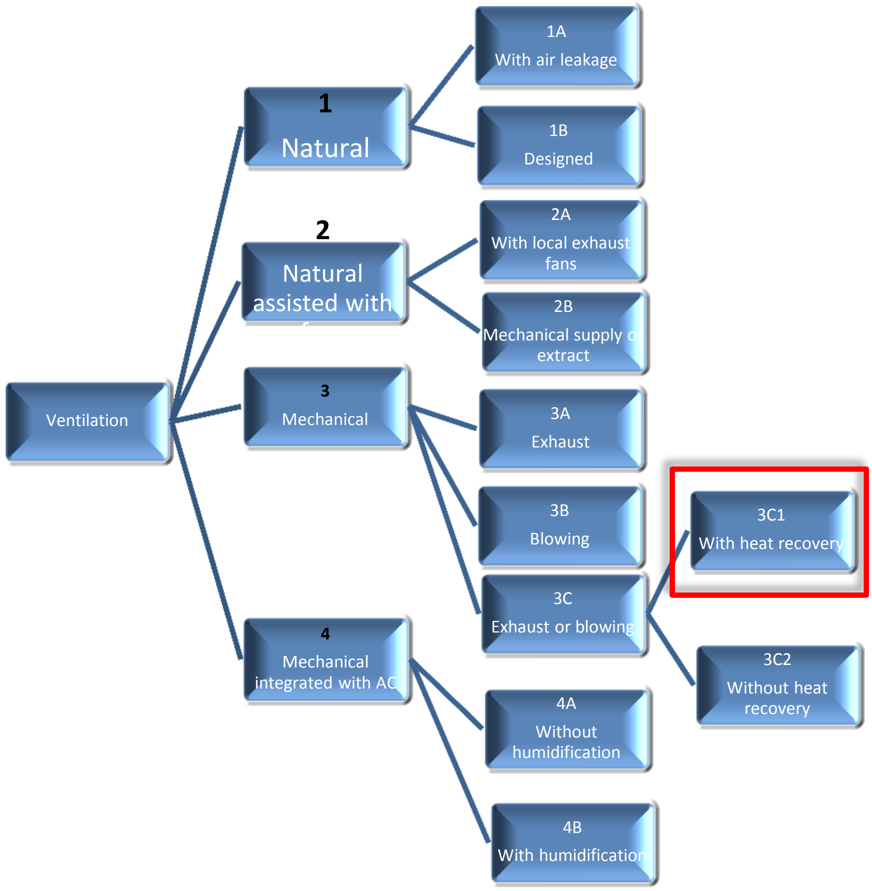


Figure 2.1 Scheme of ventilation systems classification

There are some problems in ventilation mind in some European countries nowadays. Constructive schemes, materials that were used for buildings, sanitary, ventilation, electrical equipment become obsolete; they need to be changed as soon as possible. That is a typical situation for such countries as Bulgaria, Romania, Italy, Spain, etc. – for very old and non-modernized countries with large amount of historical and antique cities and places. But other countries that prefer contemporary way of life and unique science – France, Scandinavian countries, Germany – they have technological and innovative advantages. Figure 2.2 shows the distribution of ventilation systems through some European countries and the percentage of using different ventilation systems.

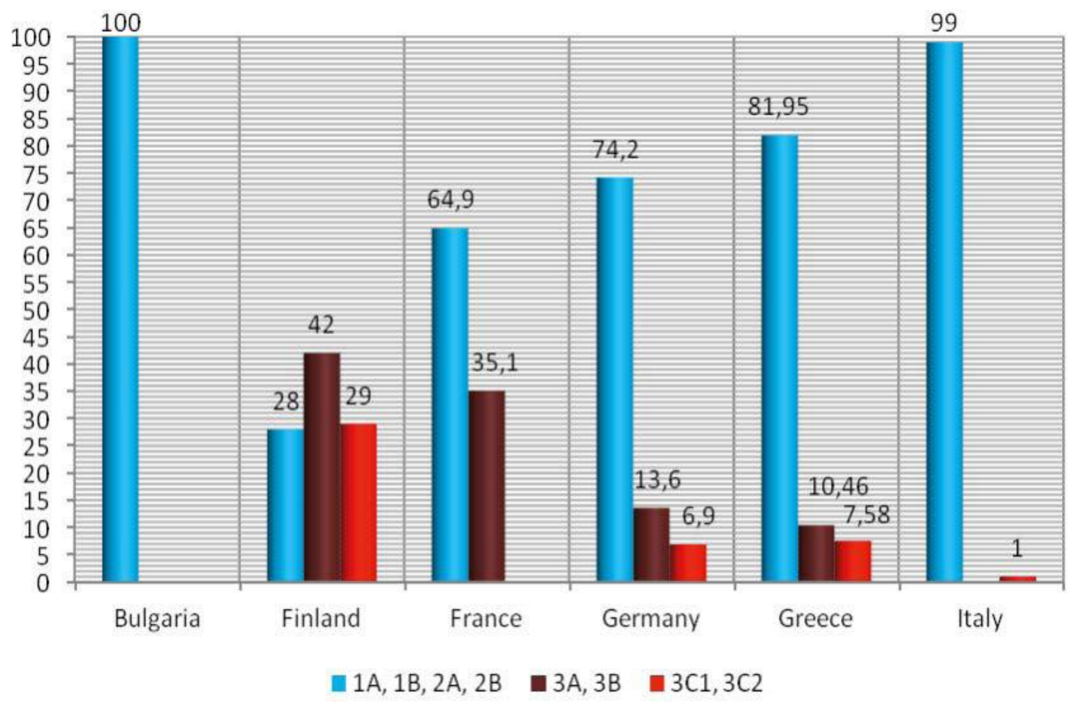


Figure 2.2 Distribution of ventilation systems in percentage from the total number of apartment buildings in the existing building stock.

The European residential building stock (in m²) accounts for 75% of the whole building stock, from which 64% is taken by houses. Figures 3-5 show the distribution of ventilation systems in the building constructed during each indicated time period.
Looking at the development of ventilation systems it is evident that in all countries the use of natural ventilation systems is decreasing in favour of mechanical ventilation systems. The evolution is different in all counties but the trend is the similar

- Before 1980 all countries used mainly natural ventilation;
- Finland was within the first countries to make a change i.e. before 1959, by introducing mechanical supply and/or extract ventilation systems; gradually the situation evolved reaching the point that all after 2004 constructed buildings have only mechanical ventilation systems;
- For Greece 1978 was the turning point after which more fan assisted natural ventilation and mechanical extract and/or supply systems were used; the situation has been slowly evolving but still natural ventilation accounts for half of the currently constructed houses;

- Romania adopted the new regulation in 2010, after which 20% of constructed houses have mechanical ventilation systems; still until 2008 more than 99% of buildings had natural ventilation systems;
- Russia during the 20th century used mostly natural ventilation – 90%, only several industrial spheres were used mechanical ventilation in plants and other facilities where exhaust system are quite necessary – 5%

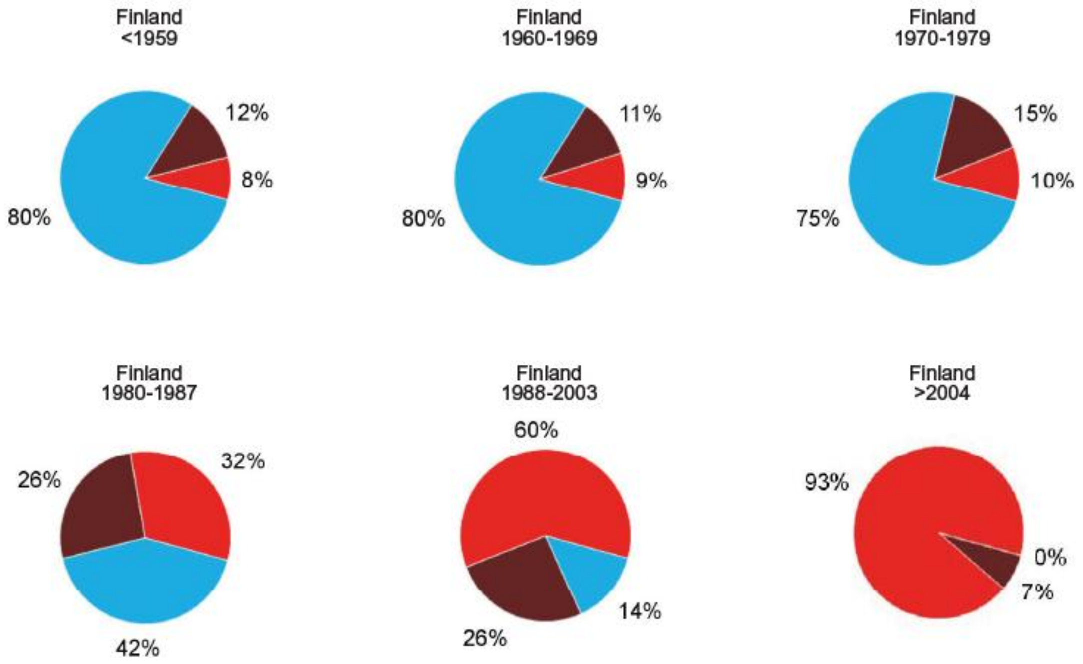


Figure 2.3 The distribution of ventilation systems in houses by construction year in Finland: before 1959, 1960- 1969, 1970-1979, 1980-1987, 1988- 2003 and after 2004.

1A, 1B, 2A, 2B 3A, 3B 3C1, 3C2.

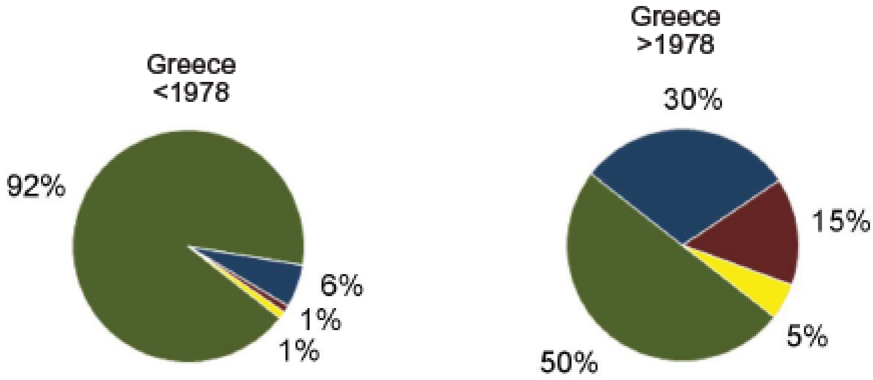


Figure 2.4 The distribution of ventilation systems in houses by construction year in Greece: before 1978 and after 1978 1A,1B 2A, 2B 3A, 3B 3C1

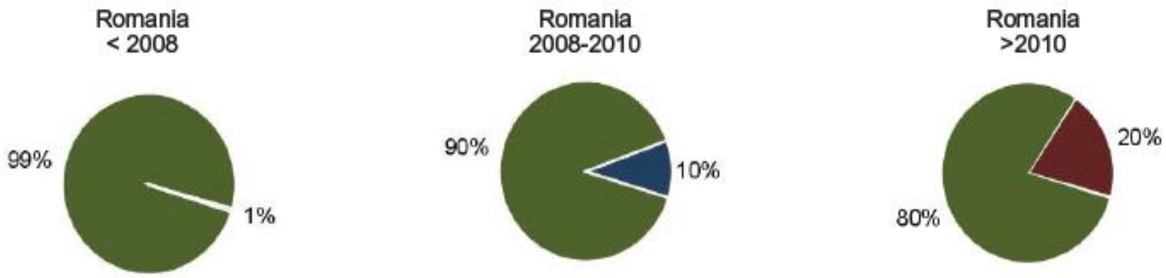


Figure 2.5 The distribution of ventilation systems in houses by construction year in Romania: before 2008, 2008-2010 and after 2010 1A, 1B 2A, 2B 3A, 3B

As a conclusion, the distribution of ventilation systems has had a similar evolution from natural ventilation systems towards mechanical ventilation systems. The evolution occurred sooner for some countries than others but it is clear that lately mechanical ventilation practices are forced by emerging regulations regarding energy efficiency and performance. But still, as most houses from the building stock are old houses the overall distribution of ventilation systems allocates the greatest share to natural ventilation systems. (Andrei Litiu, 2012)

3. **ELPO PANELS**

The main question when designing and preparing a ventilation system is how to provide fresh air inside the house. The second important question is how to remove dirty, polluted air out of the building. Pipes and ventilation channels are used for that purpose. A typical way is to lay a pipeline through the whole building from the bottom floor (or ground shelter or ground floor) to the top floor or roofing system. It is also necessary to foresee holes in the floor slabs for pipes on the design stage. After all pipe hole positions are clear, concrete designers should recalculate the slab or wall with weakenings and geometry changes. There are a lot of disadvantages and inconveniences in a production process. First of all, the formwork should be incomplete (non-continuous). The opening for pipe should be little wider than a pipe, avoiding problems of size disperancy. After pipe settlement to the project position, all gaps between holes and pipes should be filled with concrete. This process needs a strong formwork, that is hard to prepare. The real way to solve that problem was the invention of Elpo elements. Elpo element is a prefabricated concrete element one – store high with pipes, installed inside it. Those panels could include such kinds of engineering systems, as water supply and waste water pipes, heating and ventilation pipes. After the decision about positioning of engineering services was made, the drawings and technical requirements go to the plant that could cast and produce the whole element.

The investigation purpose of the thesis is Swedish Krona residential complex, situated in Saint – Petersburg, Fermskoe shosse, 22. This project is quite unique for Russia, it has a lot of innovations and ecological implementations. Furthermore, NCC company engineers decided to use Elpo as the main elements for engineering services in all buildings of the residential complex (it consists of 5 stages, each stage has from 2 to 5 buildings). See the detailed 3D visualization and description of stages in Appendix 1.

Elpo panels were used in Saint – Petersburg for the first time by Finnish company YIT Lentek, in the beginning of 2000. These panels were quite new for Russian market that time, the cost of Elpo was high and nobody knew how to

install it. After few years the development of Swedish Krona project was started and the decision about Elpo was made. Because of Finnish management team and their progressive way of thinking, Elpo panels were installed and approved successfully.
There are a lot of advantages when using Elpo panels:

- There are no problems with esthetical view in bathroom or kitchen, there is no necessity to cover ugly looking plastic pipes
- There is no noise from water running down inside pipes, concrete cover deadens all sounds
- The mounting becomes easier
- Possibility to save useful square of the building
- Ecological preferences – there is no plastic or concrete rubbish on the site
- Reducing the time of construction
- The surface of panels is ready for finishing
- Individual decisions according to experience of Elpotek Oy designers.(Elpotek Oy, PPT file)

Elpotek Oy is a Finnish company, situated in Kotka, that designs, produces and sells such panels. Panels consist of all necessary pipes (for example waste water pipes, ventilation pipes and shafts, heat pipes and electricity ducts) installed inside a loadbearing concrete panel. Simultaneously, such a panel could provide engineering services and be the loadbearing part of a wall with square economy. The technological cycle begins when Elpo designers receive the preliminary HVAC and water systems drawings from the architect or engineering services designer. Elpo designers could improve or add something useful to the project. After the final approval with the client, the production could start immediately.

The panels are used in Swedish Krona residential complex only include canalization pipes and ventilation ducts. All heating and water supply pipes are located outside of the Elpo panel, because of the project decision.

3.1 Drawings

Typical drawings that are received from Elpo factory look like scheme for mounting. See the drawing in Appendix 2. There are exhaust ventilation exits 50 cm below the ceilings on each floor, waste water pipes and few ventilation ducts. The left part of the drawing schematically shows the section of one Elpo panel inside the building. There are also dimension of floor slabs and floor heights. The place of junction between two panels is on the top of the floor slab, the panel after mounting could become a part of loadbearing construction. Places of turning points, angles and diameters of air ducts are also shown on the schematic section. Small triangles show the places where the main air duct changes the diameter. On the 3rd floor the diameter of the pipe is 160 mm, but after gradual change of sizes it becomes 315 mm on the 9th floor. The reason of these changes is to control the pressure inside air duct and air velocity. But on the other hand, the power losses could be significant in case of diameter change, and the gusset details that provide slight junction are more expensive (about 1,5-2 times) than one straight part of a pipe. On the right part of the drawing there is a cross section of the panel with adjoining walls. There are main air duct in the central part, two additional air pipes of 125 mm diameter, which go out from the panel body to the flat by means of junction pipes and one canalization pipe 110 mm with exit. The final sizes of Elpo panel in that case are 900x450 mm, with 15 mm gaps between the panel and the wall of the flat. The drawing scale is 1:10 that provides quite high detailing. Concrete class is B15.

3.2 Installation

Elpotek Oy has a huge plant that permits casting of one post at a time, which guarantees compatibility of posts after cutting. After concrete curing, Elpo panels are packed floor by floor and go straight to the construction site of the client. Figure 3.1 shows how transportation of Elpo panels to the tower crane was made on the construction site Swedish Krona.

Figure 3.1 Transportation of Elpo to the construction site

The process of mounting of the Elpo panels is quite simple. There is a written instruction of installation for all projects that is provided together with panel boxes. There are also mounting instructions available on their web-site. The main steps are as follows:

- There is a preinstalled steel loop in the edge of the panel that is useful for lifting by crane. There are also safety belts and chains to protect on-site workers and avoid accident situations.
- The maximum angle between branches of lifting chain and lifting loop should be less than 60°.
- After settlement to the final position, the safety belt should be moved out.
- The gap between the first panel and the walls should be about 15 mm.
- Clean up the butt-end of panels from dust and rubbish.

- Put guide rods to the butt-end.
- Because of safety reasons always use a piece put on the butt-end.
- Use the Elpotek joint nipples.
- Smear by lubricant the joint liners of both panels and joint nipples.
- Push the joint nipples until the lower edge of mounting panel.
- Direct the panel by guide rods.
- Control the junction between nipples.
- Control the correct positioning of tubes settlement and vertical position of the total construction.
- Put the distance pieces between panels.
- Install distance pieces also into mounting aperture around the panel.
- Set the bearing parts on the reinforcing space.
- Put the regulated support on the concreting region (Elpotek Oy, PPT file)

Figure 3.2 describes the main parts of the mounting equipment that are useful on site. Figure 3.3 shows the unit of jointing between the first Elpo panel and the bottom floor slab (or first floor slab). The pink dotted line shows the border between the responsibilities of the client (tubes and floor slab should be done before Elpo panel will come to the site) and Elpotek Oy. Figure 3.4 describes the main additional parts that are important for correct installation such as nipples, guide rods and rubber lines for close contact of the pipes.

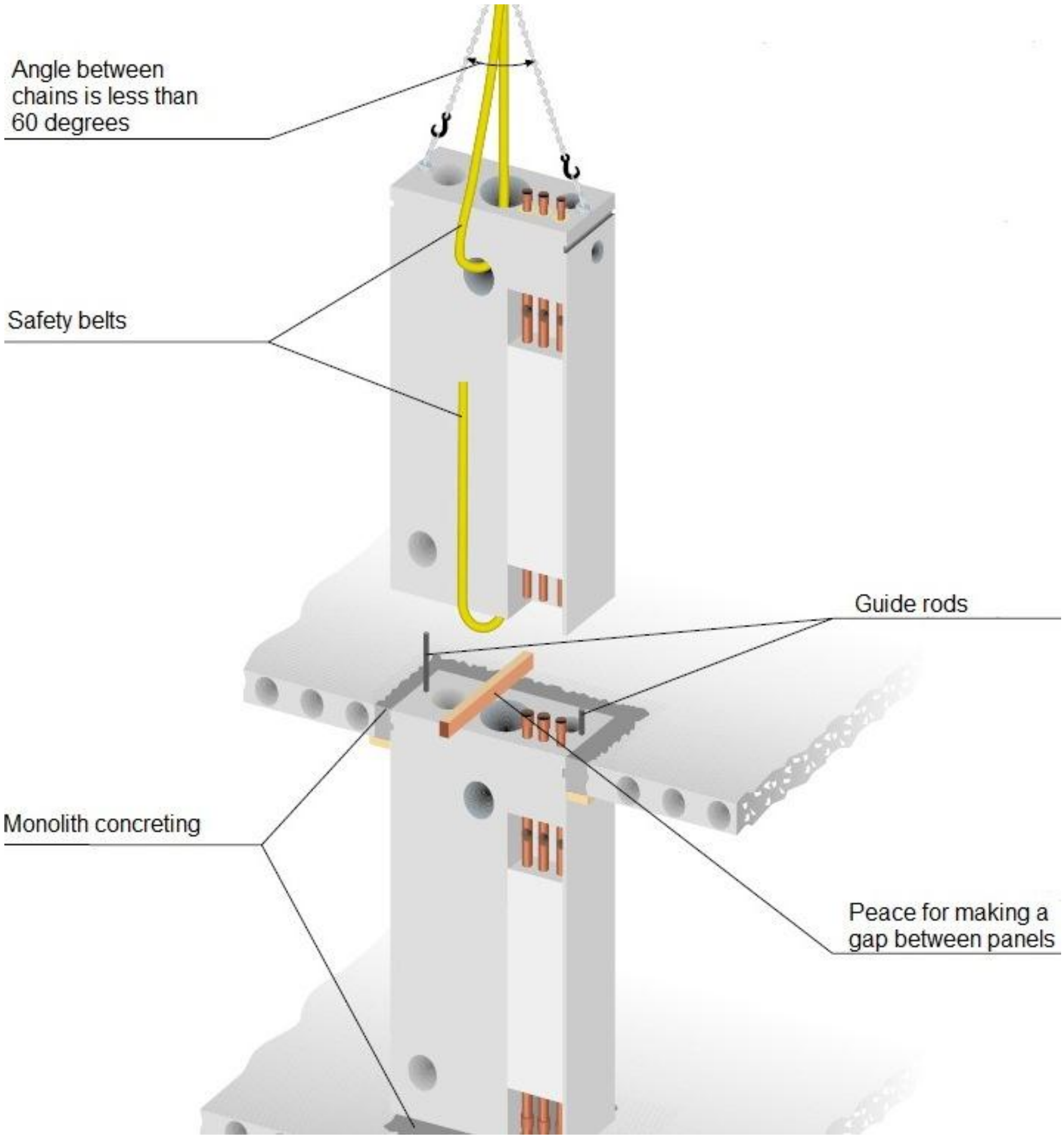


Figure 3.2 ELPO panels mounting scheme

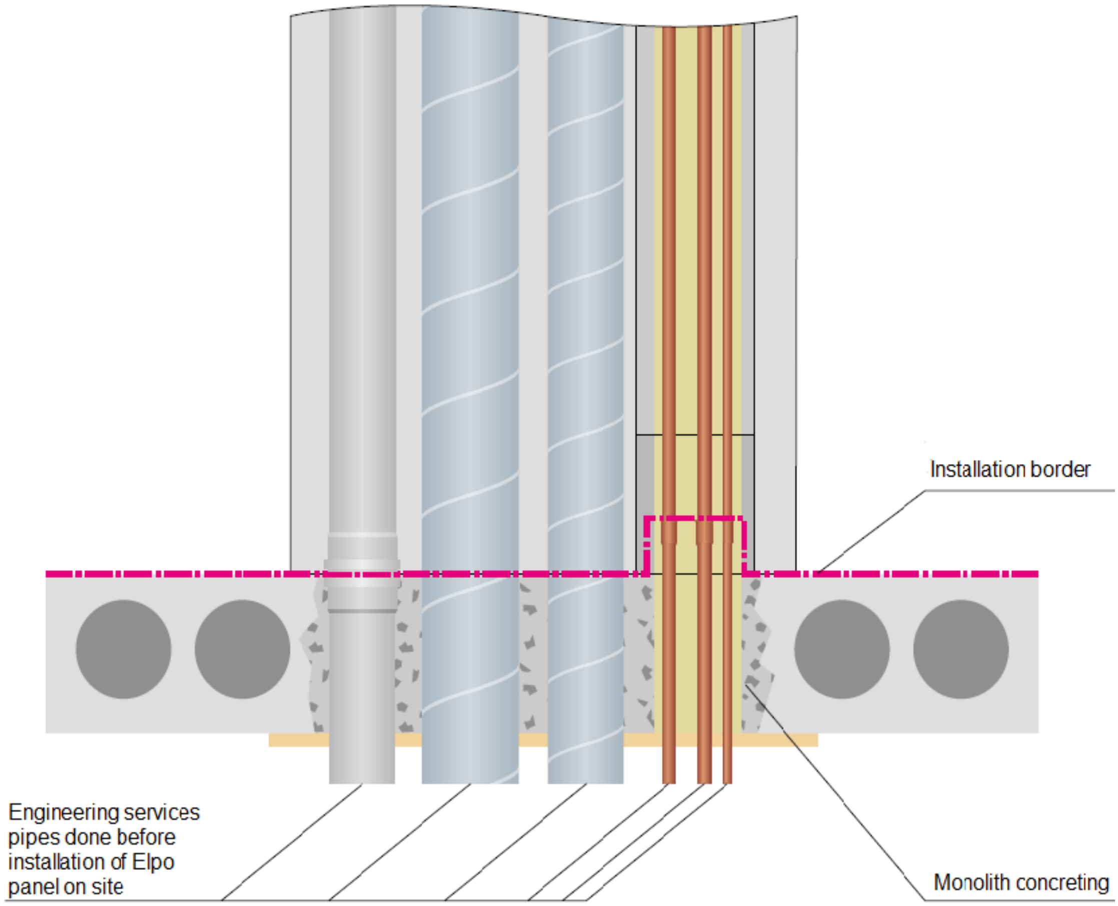


Figure 3.3 Junction unit of 1st Elpo panel and on-site engineering communications (typically bottom floor unit)

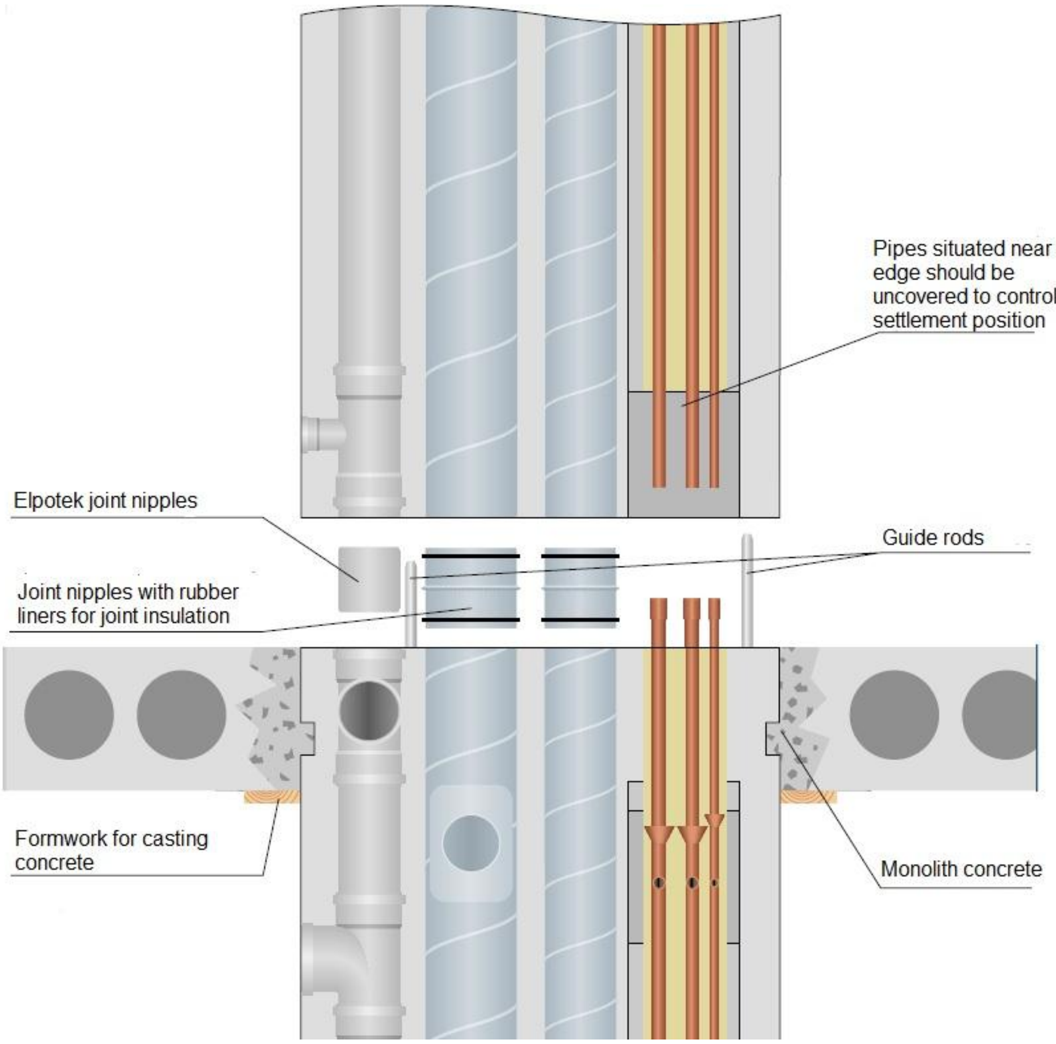


Figure 3.4 Section of the junction between two panels. Places of casting

4. HEAT RECOVERY AND VENTILATION SYSTEM

4.1 Working principles

Heat recuperation or heat recovery system is the collection and re-use of heat coming from any processes of human being (i.e. cooking, heating of inside spaces, warm water) that would be lost when using simple or traditional ventilation. Every year people lose about 40% of payments through old ventilation systems and imperfection of their houses. The heat energy goes out by means of ventilation pipes, doors and windows gaps and bad insulation layers. Heat recovery can help to reduce the overall energy consumption of the process itself or provide useful heat for other purposes. For example it is possible to create a special water powered floor slab heating system. There are thin pipes below the covering layer (parquet, ceramic tiles, etc.) and water inside them. Energy that is saved by heat recuperation equipment could be used for water heating and as a result – heating of floors.

Ventilation system provides fresh air inside the building. There are also heating plants inside to make air as hot as it is required by normative documents. But there are also so many heating resources inside the building and all that heat energy is lost when the air is extracted and dumped into the environment. (Carbon trust, 2012)

There are several main sources of excess heat in a flat or house:

- ventilation system extracts
- boiler fuel gases
- boiler blowdown
- air compressors
- refrigeration plant
- high temperature exhaust gas streams from furnaces, kilns, ovens and dryers
- hot liquid effluents
- power generation plant

- process plant cooling systems.

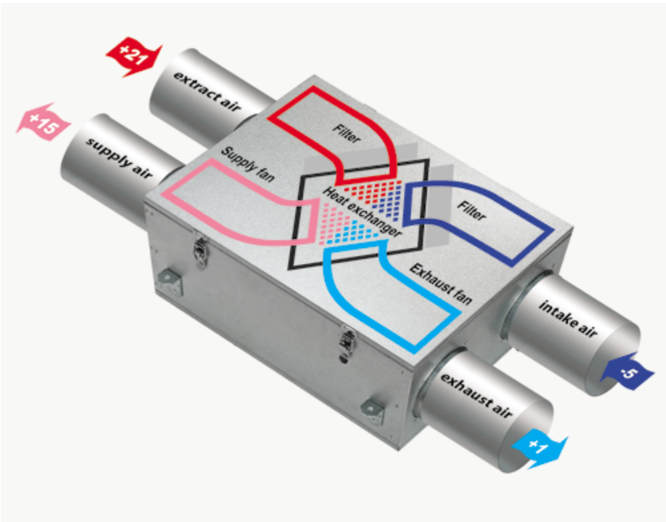
(Carbon trust, CTL142, 2012)

The most cost-effective use of waste heat is to improve the energy efficiency of the heat generating process itself. There are also possibilities to use saved heat such as:

- pre-heating of combustion air for boilers, ovens, furnaces, and so on
- preheating fresh air used to ventilate the building
- hot water generation, including pre-heating of boiler feed water
- space heating
- drying
- other industrial process heating/pre-heating
- power generation.

Recuperation technology is by far the most common form of air-to-air heat recovery and is used in a variety of air handling units with different air volumes. This technology can be linked with additional heating and cooling coils to reduce the amount of energy required to maintain internal conditions. A plate heat exchanger (or recuperator) transfers heat between the supply and exhaust streams of an air handing unit. It recovers energy from extracted air that would otherwise be lost to the atmosphere and uses it to pre-heat (or cool) the incoming fresh air. The main principle of all recuperation equipment is shown in Figure 4.1

Figure 4.1 Scheme of recuperation plant.



Cold intake air from outside is moved by the supply fan first to the supply filter where it is purified, then to the recuperator where it absorbs a greater part of thermal energy from extract air and then supplied to the room. (Vents, 2013)

4.2 Unique ventilation system in Swedish Krona residential complex

Swedish Krona ventilation system consists of exhaust ventilation Elpo panels, situated in each floor and special recovery plants in each flat. The first implementation of heat recovery system was done on building 15 of the 3rd stage of construction, shown in Figure 4.2. Swedish Krona was the only complex in Saint-Petersburg that received permission and all necessary approvals from authorities and this fact is still the same. The decision about the usage of heat recovery system was made on the project stage. There is not only a heating supply system that is maintains the inside temperature in the flats, but also a ventilation system. Real drawings of the ventilation system 15th building can be seen in Appendix 3. Each flat is equipped with individual blowing-exhaust plant cupboard type, which provides preparation of blowing air and critical air change inside the flat. Sound suppressing units and jointing air ducts locate in the spaces of suspended ceiling of sanitary cabin and hall.

Figure 4.2 Building 15in which the heat recuperation system was installed

Exhaust air heats the entrance air preliminaring, before the former is going out. Air removal valves are situated in sanitary cabins, bathrooms and kitchens.

Air change is calculated according to Russian norms. The total air change for 1 m^2 of living area was taken as 3 m^3/h. For sanitary cabin the air change is 25 m^3/h, 60 m^3/h is for kitchen with electric stove and 60 m^3/h of supply air is for each inhabitant. Table 4.1 shows the difference between Russian (SNiP 41-01-2003 Heating, ventilation and air conditioning, table M.1, p.52) and Finnish (National Building Code of Finland D2, Indoor climate and ventilation of buildings, p.32) norms concerning air changes.

Air flow	Supply air				Exhaust air	
Standard	Russia	Finland	Russia	Finland	Russia	Finland
Method	Per person		Per cubic meter			
Space/ Units	m^3/h	m^3/h	m^3/h	m^3/h	m^3/h	m^3/h
Living area	30	21,6	3	1,8		
Kitchen					60 – for electric stove	29/90* otherwi

		100 – for gas stove	se 72
Bathroom		25	36/54** otherwise 54
WC		25	25/36** otherwise 36
Storage		1,6	10,8

Table 4.1 Comparison of natural and mechanical forced ventilation system

* – guideline value when the boosting of cooker hood air flow rate can be controlled separately for each room or each dwelling; otherwise the guideline value for cooker hoods is 20 dm³/s.

** – guideline value when the boosting of air flow rate can be controlled separately for each room or each dwelling; otherwise the guideline value for the air flow is the same as the boosting value during periods of occupancy.

An example of using these numbers is the calculation of air changes for a typical 2 bedroom flat. Calculation characteristics: the total square is 65 m^2, separate bathroom and WC, cloak room, 2 inhabitants, electric stove. Table 4.2 shows the comparison of calculations according to Russian and Finnish norms.

Type of flat space	Russia	Finland
Kitchen	60 m^3/h	72 m^3/h
Bathroom	25 m^3/h	54 m^3/h
Toilet	25 m^3/h	36 m^3/h
Storage	1,6 m^3/h	10,8 m^3/h
Σ air flow rate (separate bathroom and toilet)	111,6 m^3/h	172,8 m^3/h

Σ air flow rate (combined bathroom)	86,6 m^3/h	136,8 m^3/h

Table 4.2 Example and comparison

4.3 Heat recovery plant types

Nowadays there are three main types of recuperation plants that are used in construction.

The rotary heat recovery that is shown in Figure 4.3 has very high efficiency (80-96%) in terms of recovering heat and moisture of exhaust air. The direction of airflow of the supply air and extract air flowing through the heat exchanger is always counter-flowing.

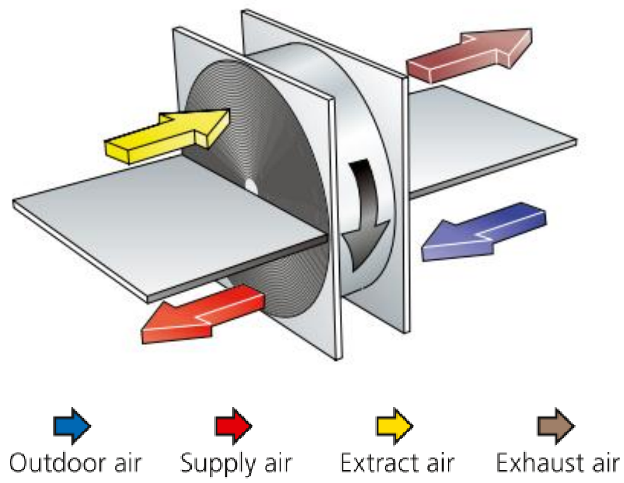


Figure 4.3 Rotary heat recovery

Coil heat recovery that is shown in Figure 4.4 is a recuperative heat exchanger that consists of two liquid coils, one on the supply air side and one on the extract air side. The used liquid usually consists of 70% water and 30% glycol. Efficiency is 50-60%

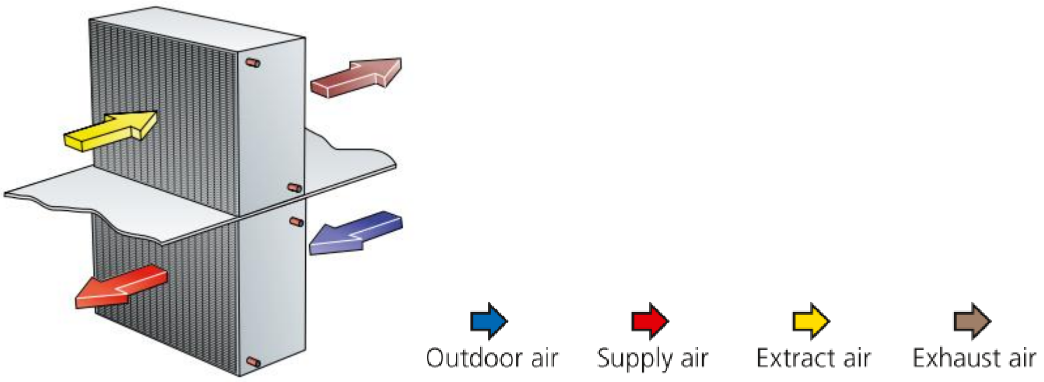


Figure 4.4 Coil heat recovery

Cross-flow plate heat recovery that is shown in Figure 4.5 can operate as recuperative heat recovery units. The supply air and extract air do not come into contact with one another. Cross-flow plate heat recovery looks like a set of aluminium or polymeric plates, which create a system of channels for the air. (Swegon AB, 2013)

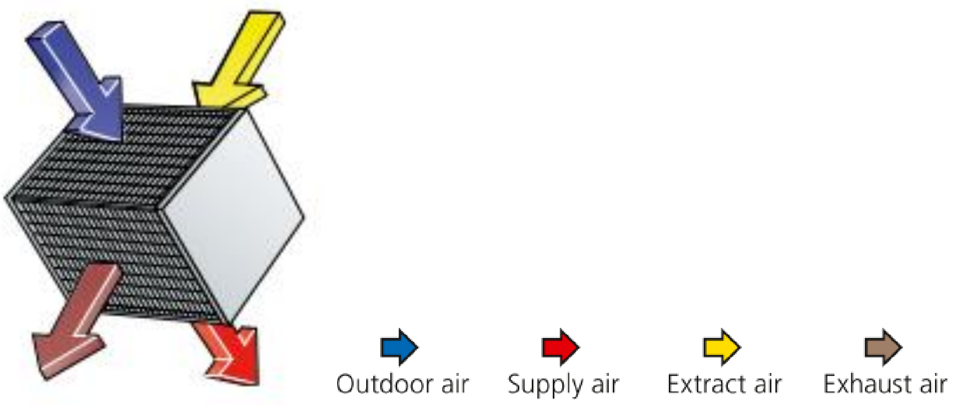


Figure 4.5 Cross-flow plate heat recovery

4.4 Swedish Krona recovery system

The ventilation plant consists of

- supply and exhaust fans
- supply air filter
- exhaust air filter

- cross-flow plate heat recovery plant
- radiator
- automatic module

Fresh air comes to the plant through unregulated lattice from the façade of the house, cleaned by the filter, goes through the recovery plant and is heated by air heat coming from exhaust air. Air flows do not mix – there is only heat transmission. Later the air is heated by an air heater until the required temperature and it goes through air ducts to the rooms and living spaces. Exhaust air preliminarily heats the supply air before the former is going out.

During the project design three different variants of supply-exhaust plants were discussed and examined. They are Komfovent (plant RECU-350VE-B-AC-C4), Swegon (plant ILTO W80, ILTO 270 M) and Systemair (plant VX250 TV/P). Table 4.3 shows the difference between three plants and their main characteristics.

Type/Characteristics	Komfovent domekt RECU-350VE-B-AC-C4	Swegon ILTO W80, ILTO 270 M	Systemair VX250 TV/P
Dimensions (heightxwidthxthickness)	710x740x340	549x598x598	570x295x600
Weight, kg	42	45	30
Supply voltage, V/Gz	230/50/1	230/50/1	230/50/1
Maximum power of current, A	5,76	7,5	10
Electric heater	1 pcs	2 pcs	1 pcs
Filter	2 pcs - F7	2 pcs - G3, 1 pcs - F7	1 pcs - F5, 1 pcs - F3
Heat recovery	2 pcs	1 pcs	1 pcs
Heater power, kVt	1	1/0,5	1
Fan power, kVt	0,27	0,23	0,23
Power of electric engine, kVt	1,27	1,73	1,23
Type of heat recovery	Cross flow double plate heat recovery	Countercurrent plate heat recovery	Cross flow plate heat recovery
Type of fan	Centrifugal	Centrifugal	Centrifugal

Type of engine	AC	EC	AC
Automatics	Integrated, with remote control on the wall	Control from control panel	Preinstalled control panel
	3 levels of intensity	Regulation of air spending	Regulation of air spending
	Supply air temperature control	Supply air temperature control	Supply air temperature control
	Energy saving (mode winter/summer)	Mechanical by-pass screen	Summer mode
	OVR function: constant level of CO2, humidity, demand ventilation	OVR function: constant level of CO2, humidity, demand ventilation (presence sensor)	-
	Turbo function	-	-
	Supply air temperature sensor	Supply air temperature sensor	Supply air temperature sensor
	-	Filter change detector	-
	Rotor's engines protectors	-	10 A protector
	-	Freeze protector (utilizer)	Freeze protector (sensor)
	-	Choke of the cooker hood	-
	-	Night cooling	-
	-	Communication (DDC)	-
	Emergency system switch off		
Heat utilization, %	90	80	85
Possibility of cooker hood installation	+	+	-

Sound characteristics (supply/exhaust/outside), dB (A)	65/53/45	74/63/49	65/61/47

Table 4.3 Comparison of three project decisions about ventilation plants

After comparison and discussions Komfovent plant was chosen. The main part of that ventilation plant is a cross flow plate recovery, that is produced by aluminum plates. These plates create the channel system. Figure 4.6 shows the plate heat recovery principles of work.

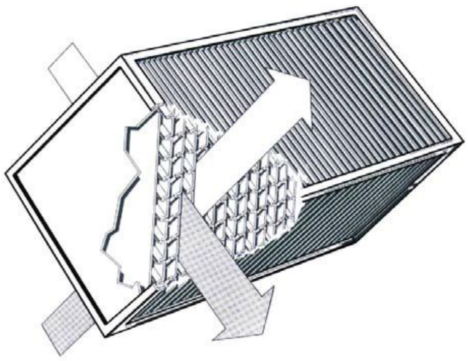


Figure 4.6 Plate heat recovery. Aluminum plates and air flows.

Exhaust air, warm in winter (sometimes colder than outside air in summer), goes through every second channel of heat recovery and warms the plates. Supply air goes through the other channels and is warmed (or cooled in summertime) when comes into contact with plates, heated by exhaust air. The efficiency of such a process is quite high – more than 70%. Heat recovery could work in a «dry mode», or with condensation. When the outside air temperature is below 8-12°C, condensation is freezing. A heat exchanger is settled inside the supply plant and it creates the separate module, situated in supply and exhaust air duct, as shown in Figure 4.7.(Кудрявцев, 2009)

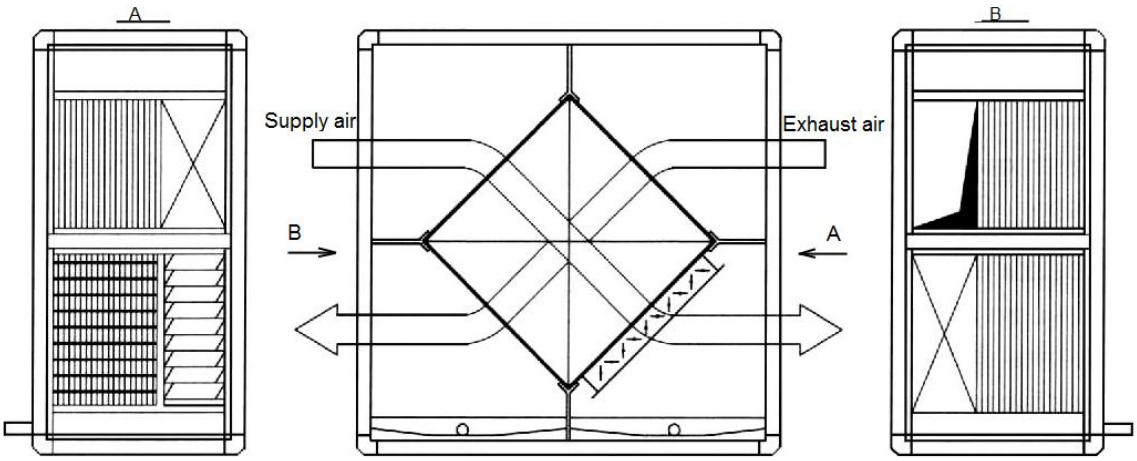


Figure 4.7 Plate heat recovery with heat utilization

The usage of such recovery systems is really helpful in small cottages or village houses, zero energy houses and passive houses with proper insulation. Energy consumption compared to the total energy profit and heat utilization is small and helps to receive about 20-30% of full year heating payment. Energy back is approximately 3.1kVt. The installation of such equipment could save money for the whole multi-apartment house. Benefit when using this Komfovent staff from heating payments could be more than 40000 roubles per year (1000 euros).

4.5 Moisture problems

Few moisture problems were discovered and studied during the project and the construction phase. The first problem is when the temperature of outside air falls below 8-12°C, condensation occurs on the wall of channels and it freezes. There is a decision concerning that fact, made by manufacturers. To collect moisture from condensation the tray is installed below the heat recovery plant. There is a necessity of a drip pan inside the exhaust air duct when the air velocity is more than 3 m/s. Heat recovery should be oriented in such a way that the water from condensation falls down to the tray and removes from it. But it is also important to protect the heat recovery from freezing. Automation system could help in this case. The supply air goes through a special ‘by-pass’ duct for a short time and warm exhaust air goes through heat recovery, melting them.

The second problem, concerning water condensation was discovered during the construction stage. The contractor detects wet parts on the air ducts going from heat recovery system to the Elpo panel. There is no special drainage system in ducts lead from recovery to Elpo element at all, or special drains in the body of heat recovery, that is why some moisture occurs on the pipes. The decision was made immediately: heat insulation of 20 mm thickness is necessary to prevent moisture problems. The technical possibilities of water vapor condensation were discussed in Finnish norms. The thermal insulation is obligatory in air handling units, chambers and ducts to prevent condensation that will cause damage to the structures or ventilation system.

“Air ducts shall be provided with thermal and vapour barriers in such a way that any indoor air humidity will not condensate into water. For instance outdoor air ducts located in heated areas of dwellings and extract air ducts located downstream from heat recovery equipment shall be provided with thermal and vapour barriers.” (National building code of Finland D2, Indoor climate and ventilation of buildings, 3.8.5.1)

There are the following reasons of condensation occurs. Efficiency of the heat transport process for heat recovery is counted by relative temperature changes (temperature efficiency)

$$\theta = \frac{t_{22} - t_{21}}{t_{11} - t_{21}} \cdot 100,\% \quad (4.1)$$

Where θ is the temperature efficiency (relative temperature changes), %

t_{22} is the temperature of supply air near the heat recovery exit, °C

t_{21} is the temperature of supply air near entrance to the heat recovery, °C

t_{11} is the exhaust air temperature near entrance to the heat recovery, °C

The degree of efficiency of the heat recovery is 60%, t_{21}=-26°C (according to the minimum temperature in winter months in definite type of country place), t_{11}=23°C, t_{22}=0,6* (23-(-26)+(-26)=3,4°C-temperature of supply air after heat recovery. The air was heated from -26°C to +3,4, that is 29,4°C. Inasmuch as the expense of supply air is equal to the expense of exhaust air, exhaust air was cooled down as much as supply air was heated. That means that the temperature of exhaust air after heat recovery (the air goes to the exhaust duct after heat recovery) is 23°C-29,4°C=-6,4°C. But heat recovery Komfovent has the special sensor which is snapped into action when the temperature of outside air is below zero. It means that the temperature inside the Elpo panel ducts and exhaust air ducts after heat recovery will be higher than 0°C. From the previous formulas follows that 0°C will be obtained when the temperature of supply air is equal or lower than -15°C, i. e. heat recovery will not work correctly in such a temperature, all loads will be on electric heating unit. Condensation is possible when the air temperature in air duct is from 0°C to 8°C, the outside air temperature correspondingly is from -2°C to -15°C. Thus heat insulation is obligatory on exhaust air duct between heat recovery and Elpo panel. The typical construction used on Swedish Krona heat recovery plant Komfovent and obligatory places of insulation are shown in Figure 4.8

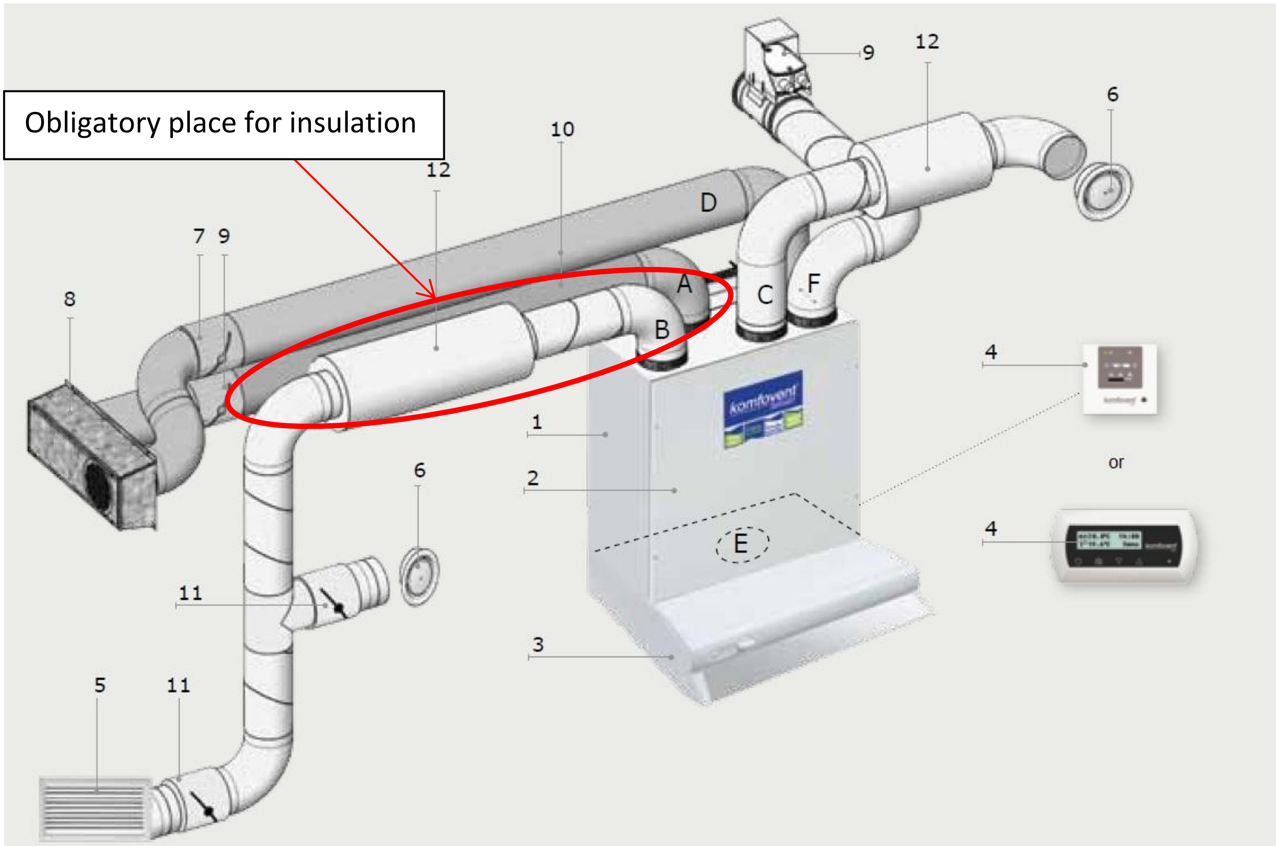


Figure 4.8 Komfovent principal construction.

1 - Ventilation plant, 2 – The forward panel of the plant. Decoration is possible, 3 – Cooker hood Komfovent (depends on client's wish), 4 –

Remote control automatic panel C4 or C4 PLUS (sensor), 5 – Grid, 6 – Diffuser, 7 – Check valve, 8 – Supply/exhaust air grid, 9 – Valve with drive, 10 – Insulated air duct, 11 – Adjusted valve, 12 – Noise-killer, A – Outside air, B – Supply air, C – Exhaust air, D – Removed air, E – Exhaust air from kitchen (by-pass – exhaust without heat recovery), F – Additional extract (by-pass – exhaust without heat recovery)

(Amalva, 2013)

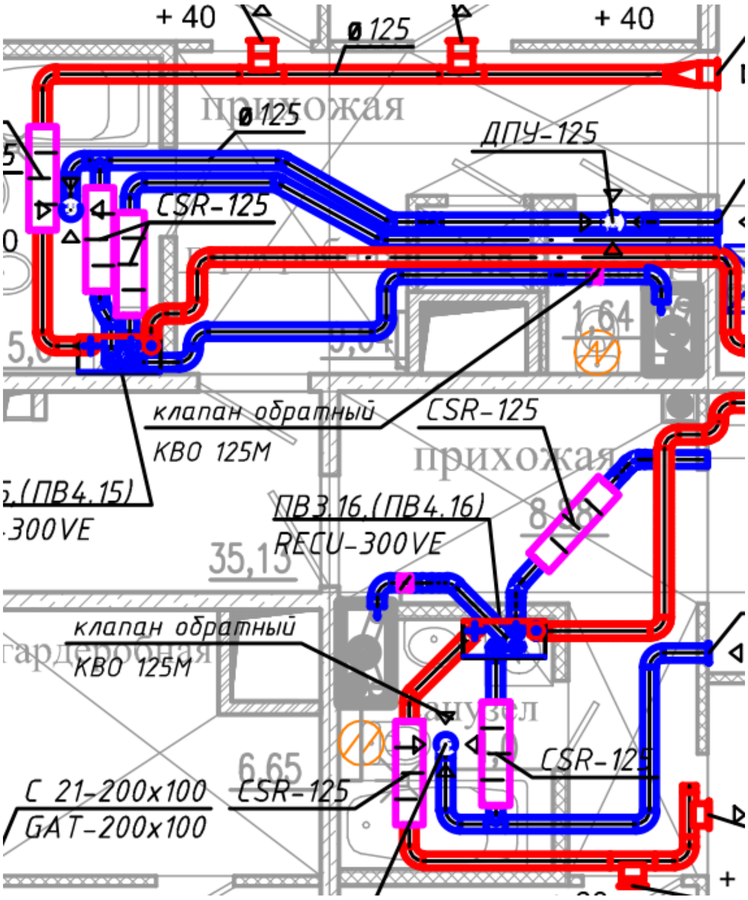


Figure 4.9 Part of flat plan on ventilation drawings. Swedish krona. Building 15

5 READY-MADE SANITARY CABINS

5.1 The history and experience of USSR in use of box units and prefabricated ready-made sanitary cabins

The Soviet Union has a great experience in implementation of box units in housing during the second half of the twentieth century. The purpose of such implementation was to industrialize and make the process of construction faster. The aims of usage of the box units are economical optimization and simplification of mounting process.

The first design model of light-weight box unit was created in USSR in 1930 by prof. Ladovskiy and architect Karaulov. The main idea was to insert that blocks to the reinforced concrete bearing cells. The practical implementation was started in 1955 when three-dimensional monolith reinforced concrete sanitary units were manufactured. The first experiment reinforced concrete box unit buildings were constructed during 1958 and 1960. The box-unit, the box-unit/panel, and frame/box-unit systems were tested; precast and monolith concrete blocks were applied. Different types of structures (i.e. the cup type, the cap type, the lying cup type, semi-box units, the three-dimensional elements of the tube type) were created and examined. The materials that could be used for box units production are heavy concrete, expanded clay concrete, perlite concrete, agloporete concrete, wood, arbolite, plastic is also been studied. During experimental stage different types of sizes were tested but for room boxes few of them were chosen – 2.7 to 3.3 m wide and 4.8 to 6.0 m long. Few problems were discovered during construction. For example, it was found that frame/box-unit systems using reinforced concrete box units could not be used on a large scale since the load-bearing capacity of the box units was sufficient only in buildings up to nine stories. By 1973 blocks of flats with floor area of about 8,000 m^2 (17,000 flats) were completed in the Soviet Union with the application of reinforces concrete box units. (Oliver O.Z, 1973)

Figure 5.1 shows the building produced in the USSR in the 1970s made of box units and the mounting process.

Figure 5.1. Mounting process of box unit structure (Монфред, 1965)

The main problems that were discovered during the experimental stage, production, transportation and construction are:

1. Crack resistance of box units during production, transport, erection and maintenance (micro cracks in the units, that are not leading to the high reduction of strength capability, considerably reduce sound insulation and cause difficulties in finishing).
2. Protection of units from precipitation and temperature drops during storage, transport and erection is obligatory
3. Sound insulation is necessary to guarantee sufficient level of life
4. It is necessary to choose and invent mechanized ways of finishing and decoration
5. Determine actual indexes of box-unit construction for comparison with similar indexes for large-panel construction

Figure 5.2 below shows the process of transportation in the USSR in the 1960s.

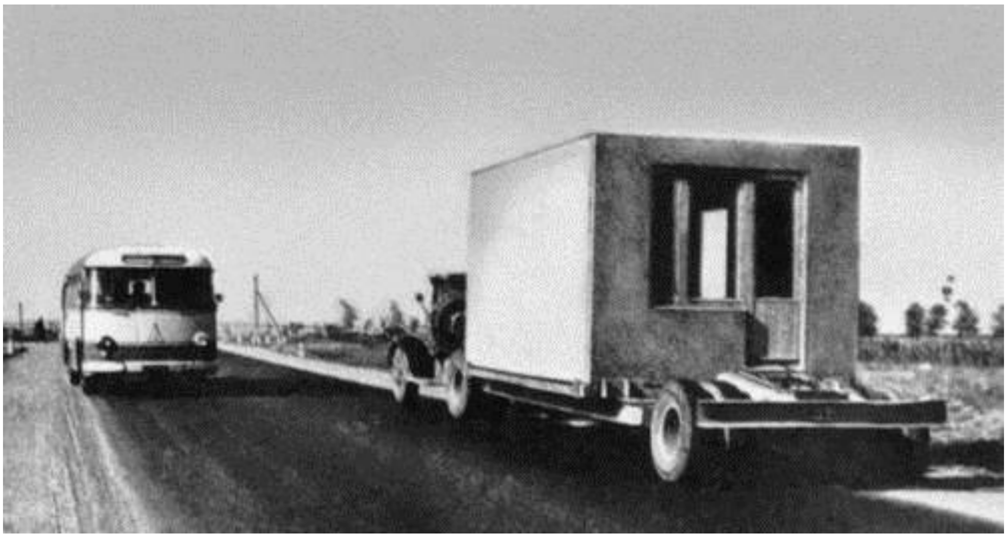


Figure 5.2 Transport of the box unit (Атаев, 1967)

After the years of researches and experiments, the government of the Soviet Union decided to use the principles of box units only in sanitary blocks. Different types of structures were implemented to use and installed in many residential complexes between the 1970s and the 1990s. Special normative document was prepared to control all phases of production, construction and maintenance. Some certain chapters from that document GOST 18048-80 Reinforced concrete sanitary cabins discussed on the next pages. Eight types of cabins were used in industrialize construction, all of them are shown in figures 5.3 and

5.4.

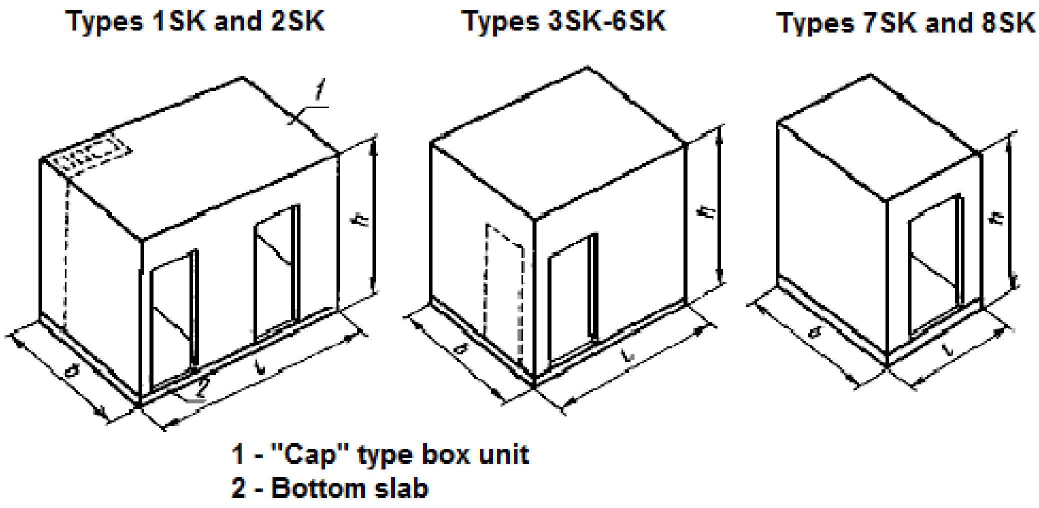


Figure 5.3. Different types of box sanitary cabins

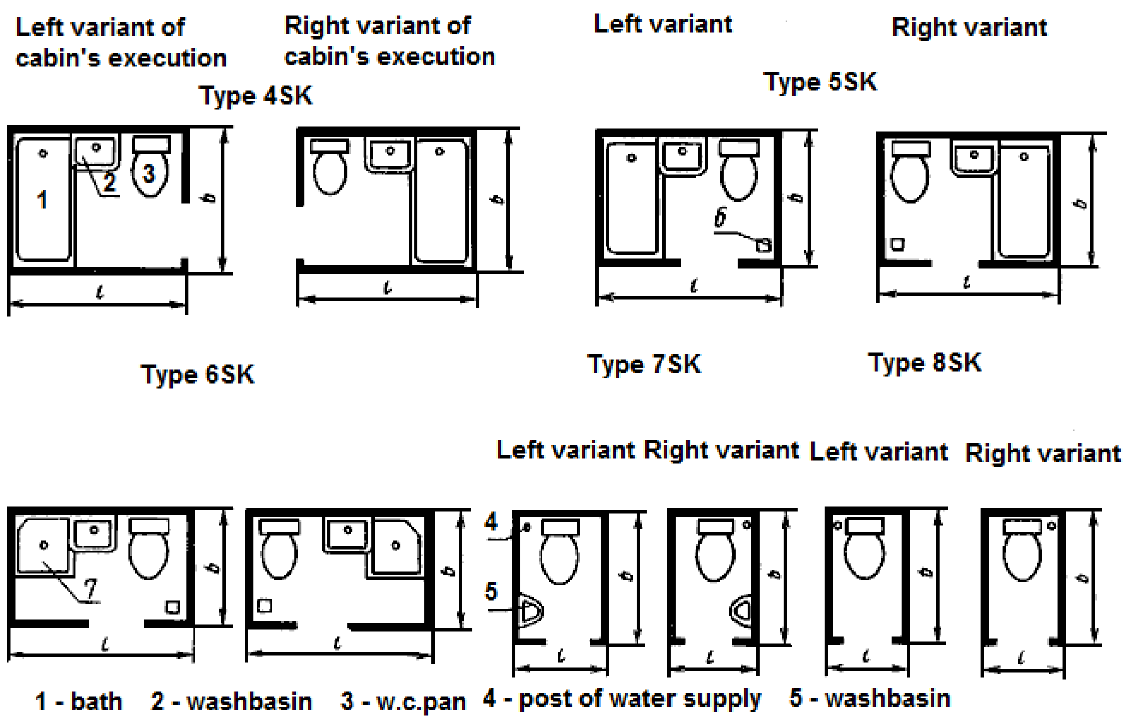


Figure 5.4. Different variants of execution of sanitary cabins.

The assembly of a cabin is possible by means of inserted details inside bottom slab and the cap unit. The minimum thickness of wall elements is 40 mm and the bottom slab thickness is 50 mm. Reinforcement of cabins is made of steel nets or welded steel frames. The bottom slab should be water-proof. The delivery of sanitary blocks is possible only with the pre-installed tubes, plant-made finishing and all necessary sanitary equipment installed. The questions about size deviations and geometrical imperfections were discussed carefully during the process of work under this normative document, because the accuracy of production influences so much on the total construction process and possible negative economic effect (for example, cost increasing because of additional work of sizes correction). The deviations of nominal sizes, that are shown on working drawings and the real sizes of a cabin should be less than shown in table 5.1.

Table 5.1 Size deviations in sanitary cabins

By length and width of a cabin from the outside	±10
By height of a cabin from the outside	±12
By the position of partition	±8
By sizes and positions of openings	±5
By sizes and positions of door openings	±10
By positions of supply axis and mixer	±2

The difference of diagonal's lengths of outer surfaces of the cabins should not be more than 10 mm. (GOST 18048-80, 1982)

The following problems were discovered during the mounting process. It was quite difficult to install sanitary cabins on the exact places, because the cranes and other hoisting equipment were not as accurate as now and have no large carrying capacity. The result of that were geometrical and axial gaps between project decisions and the real results of mounting. The other problem is micro cracks that occured in the surfaces of cabins. The cracks increased the price of finishing works. Large and big scale trucks were necessary to transport the cabins. While mounting, some chips of bath's enamel occured, such damages are not allowed by GOST, that is why it was necessary to remove the damaged bath and install the other one with increasing construction cost.(Ленский, 1969)

5.2. Modern situation in the sanitary equipment market

Nowadays, when the questions about fast and high quality construction play the main role, industrialized; cheap and easy mounting of sanitary cabins and all necessary equipment becomes more and more popular. During the last years different types of fully factory assembled cabins were invented and successfully produced. It is no more necessary to make additional construction works on the building site (i.e. assembling and mounting of walls, partitions, slabs, doors, settlement of sanitary pipes and equipment, finishing works). Workers just have to put the cabin on a right place by means of hoisting or crane equipment and special loops welded to the inserted details. The new generation of sanitary cabins does not need large scale transport and hoisting machinery, the total weight of a cabin with full equipment is less than 200 kg. The new type of a cabin is equipped by all necessary equipment such a lavatory pan, shower, washbasin, energy saving light equipment, ventilation, electricity systems, all necessary water pipes, etc. After the process of assembling the only thing to do is joining of water supply and waste water pipes, ventilation ducts and electricity cables and wires and install the cabin to the final position.

Advantages of use:

1. All pipes and ducts are available for repairing, because there is no concrete filling upside the pipes.
2. It is not necessary to spend additional money and do some settlement work for lavatory and shower installation. Mounting of a cabin is easier and faster
3. The ventilation of kitchen, lavatory and bathroom could be produced at the same time as mounting of the sanitary cabin.

A frame construction of the new generation cabins consists of a light-weight aluminum frame, glazing made of shockproof red-hot glass and acryl-polymeric composite. (PreFab Lab, 2013)

Nowadays NCC has a huge experience in use of prefabricated sanitary cabins in EU countries. But Russian market still quite conservative and close for new producers. NCC Finland implemented sanitary cabins on the following projects:

- Asunto Oy Hollolan Huugo
- Asunto Oy Hollolan Hermanni
- Asunto Oy Hämeenlinnan Tulliaukio
- Asunto Oy Hämeenlinnan Tullitupa
- Asunto Oy Vantaan Kaunis Bertta
- Asunto Oy Tampereen Ninansampo
- Asunto Oy Helsingin Mestari

Finnish market is full of producers of ready-made sanitary cabins. The first one is Parmarine Ltd, the most widely known in Finland. There are two different kinds of products in that company: products for construction business – ready-made sanitary blocks, saunas and bathrooms; products for ship industry – marine rooms, cabins, ship fire doors. Actually the company had started the business only as a marine company 40 years ago. But later, after rapid development of the construction industry Parmarine decided to open a new way and the field of action – residential construction market. Parmarine Ltd products include all necessary pipes and loadbearing structures. Sanitary equipment and inside finishing is free for choose for the customer. The company also provides transport to the building site in early agreed date. (Parmarine Ltd, 2013)

Transportation on construction site could be made by suppressor-pilers or mechanical loaders with the loadbearing capacity from 3000 to 5000 kg. The average weight of the cabin is 3000 kg.

Figure 5.5 Hoisting process

Figure 5.6 Crane equipment

The installation of cabins is possible with mobile cranes (for low-rise buildings) and with tower cranes (for multi-floor buildings). Figures 5.5 and 5.6 show the special crane equipment called “cross-arm” providing uniform lifting of the cabin. The lowest part of the cabin is put on cradle with small wheels. It helps to move the cabin along the floor to the final mounting position (see Figure 5.7).

Figure 5.7 Moving of the cabing along floor structures and the final settlement.

Figure 5.8 Settlement of the cabin to the final position.

Setting on the final position is done with lifting jacks and slope surfaces for easy mounting. During installation process the following manpower resources are needed: 2 or 3 workers for strapping works on the ground, 1 crane keeper, 3-4 workers on the floor (it is possible to have 2 specialized sanitary equipment workers and 2 strappers from the ground). However, the organization of the mounting process could be different, it depends on manpower resources, project scales and the weight of the cabins used on site. After all works are done, it is necessary to protect the cabins against the water from rains and snow and different moisture occasion that could damage the outside structures, wires and pipes. The desirable view of the mounted cabin is shown in picture 5.9.

Figure 5.9 The view of the cabin after finishing of the mounting process.

The product quality of Parmarine cabins is high, the company gains experience during 40 years. But the cost of transport between two countries is quite high and it takes a lot of time. A better possibility for NCC Construction is to use home-made cabins. Now there is one company in Russia that sells sanitary cabins. But there are no plants or special factories that could produce these cabins from zero-point. PreFabLab office is situated in Moscow and they import cabins from China. The price of one cabin with all necessary equipment and inside finishing is about 500-800 euros/m^2 or about 2000 euros for average cabin. But PreFabLab's cabins are different in comparison with Parmarine cabins: the former one consists of an aluminum frame and a thermal glass, it is not necessary to make additional finishing of outside wall surfaces. Parmarine cabins need to be covered with some decorative materials from the outside. The view of PreFabLab cabin is in Figure 5.10.

Figure 5.10. PreFabLab cabin with a toilet, a shower and a hand washer unit.

The other Finnish supplier of prefabricated cabins is STX Finland. This company is a world leader in manufacturing of prefabricated cabins and bathrooms. Firstly the company had been manufactured sanitary cabins only for ships and vessels, but later it started to produce sanitary cabins for residential buildings and hotels also. The experience of production was gained since 1982; more than 125 000 cabins were delivered to the passenger vessels, offshore industry, hotels and other accommodation purposes. STX Finland is a partner of NCC Finland and these two companies have a lot of project working together. One of the main possibilities of using such cabins is that there is only one subcontractor on the site. A typical situation now is that there are a lot subcontractors responsible for water supply, waste water, finishing, electricity and so on. Cabins are prefabricated, that is to make the process of mounting and finishing as easy as possible. Furthermore, it is much easier to coordinate one subcontractor than five or more. It is also possible to choose the exact cabin that is needed; tailoring gives to the customers the infinite decisions of structure design. (STX Finland, PDF brochure, 2013). See the example of STX cabin in figure 5.11.

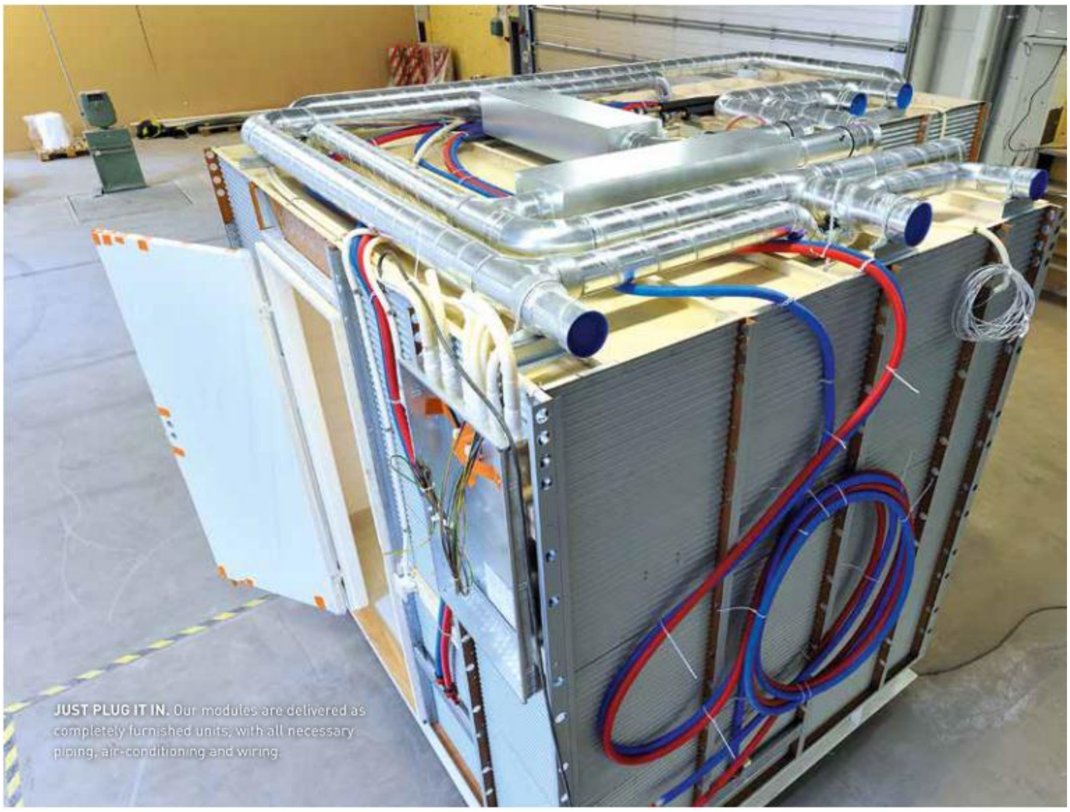


Figure 5.11 STX ready-made sanitary cabin

There are some future projects where NCC will use STX cabins:

- Asunto Oy Vantaan Käenkukka
- TA-Aso Oy Husbackankuja 4
- Asunto Oy Hollolan Hanna

Also ready-made elements could be performed as sauna elements. It consists of benches and chairs or wooden sofa when necessary, totally covered by timber and a heating element that uses energy from electricity, gas or other fuel. The sauna elements always include all necessary furniture such as pipes, ducts, electrical soccets and so on. Such ready made saunas are very popular in Finland and other Scandinavian countries, because of the history and climate conditions. Now these cabins become more and more popular in Russia. But the installation takes time and need permission from firetechnical authorities.

That is why installation of sauna elements is more comfortable for clients on construction stage, when the main contractor takes care of all firetechnical analysis and expertize. The client just has to pay the total sum of flat cost without any payments for authorities.

6 COMPARISON AND ECONOMICAL CALCULATION OF TWO SANITARY CABIN'S SUPPLIERS

In that chapter I would like to compare two main suppliers for needs of NCC Construction. NCC wants to install such type of cabins in some of its future projects. But the decision which one is necessary to choose was still not made. The first supplier and producer is Parmarine Oy. This producer is well known in Finland and has good reputation. But transportation prices are quite high, NCC has such problem now with Elpo elements transport cost. That is why other supplier – Moscow company PreFabLab, that imports such cabins from China is more preferable. The following table could describe the real prices for different variants of the construction stages and decisions. The summary table is shown below

	Parmarine	PreFabLab
Location of a plant	Finland, Forssa	China
Product	Ready-made sanitary cabins. Need to be covered by some decorative material from the outside	Ready-made sanitary cabins. Consists of glass and aluminum frame. No addition finishing needed.
Cost of an average cabin	7000 euros or 10000 euros for cabin with sauna	5000-8000 euros
Cost of 1m^2	900-1200 euros	500-800 euros
Pre-installed equipment	All necessary ducts and pipes: water supply and waste water pipes, ventilation ducts, electrical ducts and holes. Sanitary equipment – toilets, hand-washer unit, shower cabin, lockers, cranes, electric soccets.	
Transfer	Client's expenses. Distance from Finland (Forssa) to Saint-Petersburg 540 km by	Company-clients expenses. Transfer from China to Moscow is free for

	roads, or 120 km to Helsinki and then ferry transfer	client. Than from Moscow to Saint-Petersburg distance is 700 km, paid by client
Preliminary cost of transfer	156000 euros for 100 cabins (because of border tariffs, VAT and other taxes)	15400 euros for 100 cabins (average multiflat house)
Transfer on construction site	Because of not so big dimensions on construction site it is possible to move and transfer cabins by automobile or tower cranes when necessary	
Price of on-site transportation	20 euros/work hour for tower crane and 300 euros/day for automobile crane	
Price of mounting works	40 euros/day	
Advantages	A lot of projects finished already, reliable company, all constructions and materials certified in EU	New supplier with quite low prices and easy to transport product
Disadvantages, possible problems	High price, additional decoration for outside wall surfaces is needed	Some damages of glass construction is possible during mounting and hoisting process. Fire technical characteristics are not clear – it could be a problem with final state inspection concerning fire

		norms.
Total expenses	8996 euros per 1 cabin, mounted on the final place	7054 euros per 1 cabin, mounted on the final place

Table 6.1. Economical calculations of Parmarine's and PerFabLab's variants

In conclusion, the total cost of Parmarine is 21% higher than PreFabLab prices (plus additional costs for decoration in Parmarine's variant).In residential buildings sound insulation is the one of main problem – that is why use of PreFabLab's product is limited. But for hotel rooms PreFabLab's decision is more suitable – sound insulation block in this case limited by outside room walls, there are no requirements for additional sound insulation. My opinion for NCC Russia is use PreFabLab elements for hotel and office buildings and use Parmarine Oy cabins for residential and housing projects.

CONCLUSION

During writing the thesis the following problems were discovered:

1. What is going on with ventilation systems in the world now, which of them have to be used for eco-construction
2. How it is possible to manage the high effective ventilation system in the building and what we have to improve in ventilation field in so-called “green” projects
3. How the experience of the Finland branch of NCC could help to NCC Russia.

Nowadays NCC Russia improves their projects according to modern ways of thinking. One of these ways is ecologically oriented, “green” construction. Such kind of buildings demands very efficient engineering systems inside the building. NCC became the leader in such a sphere in Saint-Petersburg and won 2 prizes as “Green Construction Company” in 2010 and 2012. Main eco-technologies of NCC were studied during the work on the thesis. The most effective and interesting of them is heat recovery system. Heat recovery provides the economy of energy used for heating, effective heating of inside air and comfortable air changes inside the flat that could be set according to the wishes of the client. NCC also uses a progressive type of settlement of engineering communications. Elpo panels provide the economy of spaces and time and make the installation process easier and faster. But there is a problem, found during the importing process: the price of delivery and the total product is quite high, that is why NCC is now searching for local suppliers with similar products.

NCC also wants to install ready-made sanitary cabins on their Russian projects. Now there are no possible suppliers with local production plants in Saint-Petersburg. One company that imports such cabins from China was found in Moscow, but the price of the cabin is high and the quality is doubtful. The NCC Finland’s experience tells us about two main suppliers – STX Finland and Parmarine Ltd, which are NCC’s partners in Finland. Ready-made cabins business usually started from cabins and sanitary blocks for ships and vessels. Now there are such marine companies in Russia, but still there are no decisions for construction companies. Hopefully, soon there will be new ones in Russia. After that NCC could calculate the profit of using such products and installing them on future projects. The advantages of use are shortening of construction time, standardized decision, a lot of tailoring models and only one subcontractor instead of 5 or more. Calculation of the best decision concerning sanitary cabin’s supplier was made and the summary is to buy ready-made sanitary cabins in Finland (Parmarine Oy), because there are possible problems with fire technical characteristics and sound insulation level in glass Chinese cabins. The other advantage of Parmarine is that NCC Finland branch has huge experience in work with that supplier during many years. Other decision that was made fro NCC Russia is to use cheapest Chinese cabins for future hotel project, because there is no additional requirements for insid-flat walls for hotel rooms in Russian normative base.

In future green construction will be more and more popular. The question about energy saving and alternative energy sources will be discussed in higher government levels. That is why NCC policy concerning green building and heat recovery is very necessary now. I hope soon NCC will produce zero-energy houses in Russia as it goes all over the world. The sales of such houses and flats will be effective, because now more and more people want to buy energy efficient property to pay less for public utilities, energy and water supply.

Now Russian norms about energy consumption are less strict than in Europe or Finland, for example. But soon the situation will change and all over the world we will have the similar energy condition concerning new houses. We need a new normative base for such improvement. NCC builds according to Russian norms but some decisions about progressive ventilation types and wall thickness are based on Finnish normative documents. A lot of Finnish equipment for engineering systems ais used in Swedish Krona construction site also.

In conclusion, the decisions taken by NCC Construction on residential complex Swedish Krona are innovative and perspective. In my opinion, green construction will be more and more popular. The government should encourage companies to develop ecological construction and give them all possibilities to get new plots for construction.

FIGURES

TABLES

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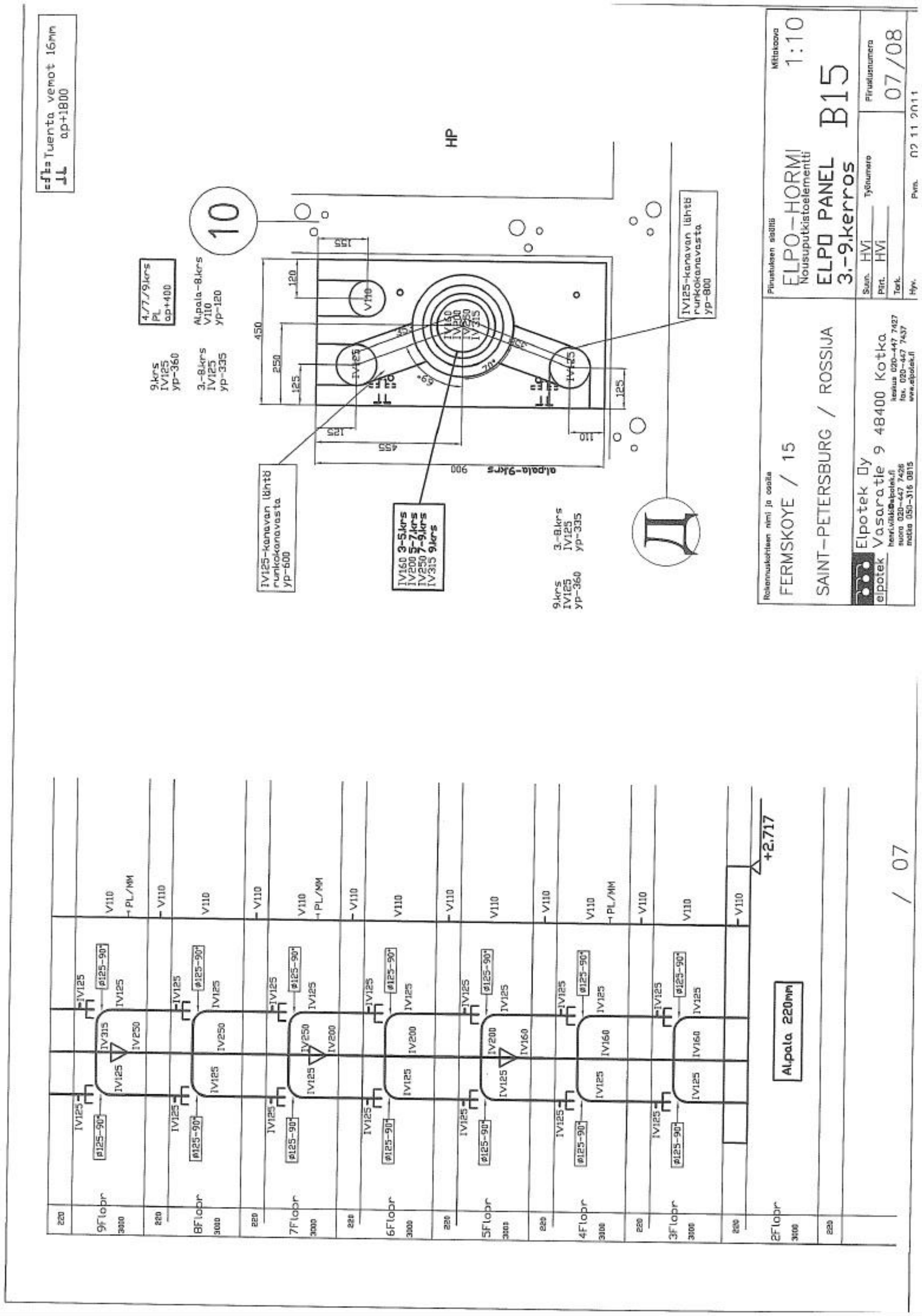
Appendix 1 Residential complex Swedish Krona. 3D visualization

APPENDIX 2. Elpotek's drawing. Typical scheme. Swedish Krona. 3rd stage, building 15, intersection of the axis Д-10. Elpo panel sections. Scheme of ducts



APPENDIX 3. Ventilation system. Floor 5, building 15