Remarks on a pilot project of renewing the Oblá 14 house in Brno, Nový Lískovec

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Contents

1 Ventilation

Within the whole project just one part seems to me as being rather imperfect: the mechanical ventilation system.

1.1 Cross-sections of ducts are to be several times larger

The key for mechanic ventilation aiming at maximum comfort and preventing energy wasting is using just very low velocities of the airflow, and consequently little electricity consumption for ventilators. The upper power limit which a really good ventilation is to obey is 0.4 W/m^{3}s. The top-quality (passive) houses do always obey it (see e.g. Stärz [1]). For a ventilation with a proposed flow of some three thousand cubic metres per second for the whole house (I quite agree with this flow, as a maximum one) it implies a maximum allowable electric input of all ventilators of just 1.2 kW.

The 0.4 W/m^{3}s value is considerably exceeded for the analogous renovated houses at Oblá 2 and Kamínky 6 already, where the airflows are perhaps just half that large **probably below 1800 m^3/h, with two ventilators 650 W each (using Atrea Duplex N2400 heat recovery unit)** [this emphasised part has been missing due to my error in the first English and Czech drafts]. In spite of that, the Oblá 14 project supposes using ducts of the same size, which are too narrow even in the above mentioned houses. No wonder that the planned electricity consuption results unpleasantly high, quite untenable for a pilot project. There is a marked difference from the Prof. Streicher's analysis [2], which speaks about a necessity to keep the velocities below 2.5 m/s (also from acoustic reasons) and gives the needed minimum duct cross-sections (1.0 dm^2 for each of the two branches to a flat, 16 dm^2 for the sum of the cross-sections of both ducts in a shaft).

Fortunately, the remedy is easy and should not add much to the costs. There is a possibility to have generously sized ducts. By avoiding any vertical separate ducts (as pipes) and using the *whole installation shaft area as ducts*. It is sufficient to separate them in two halves (in a fire-resistant way) and eventually to attach there a suitable cladding (say a glass wool with an aluminium foil at the surface). Even with all the pipes for another purposes (wastewater, insulated cold and warm water pipes, gas, power and measurement cables) the remaining areas are so large that even in the top floor the velocity won't exceed two metres per second. In detail, the whole shaft cross-section is 4 dm$\times$8 dm, the insulated pipes take 4,2 dm^2 from it, after adding a halving bar between the fresh and exhaust air and adding some sort of cladding 2.5 cm thick (they will take max. 7 dm^2) still over 20 dm^2 remains. Even with local obstacles like armatures, branches and measuring devices the condition of the flow velocity below 2.5 m/s will be obeyed with a good safety margin,

The only condition of the functionality of such solution is a sufficient tightness of the control doors to the shaft in each flat. There should be two doors, to each duct separately, ideally made in such a way that it would not be possible to open both of them at once (a shortcut would result and the ventilation would cease to work, **the wanted pressures in the ducts could not be maintained, what should be indicated by a measuring system** [this emphasised part has been missing due to my error in the first English and Czech drafts]). A switch indicating which door is not properly closed would be suitable, attached to the whole measuring and control system accessible by Internet.

The reason to use vertical ducts of just 20 cm diameter in the preceding reconstructions has been the wish to avoid the necessity of installing fire valves to each flat. The current project includes such valves already, so there should be no obstacle for using large cross-sections for vertical ducts. The pressure losses per the house height should be not over three pascals, and the necessity of any initial balancing (or regulation) of flows into the branches in various floors would disappear. The varying distances to ventilators should play almost no role, the pressure drop on the outlets and on the input filters for exhaust air (they are maybe not included in the project, but I'd be in favour of them, also because of their acoustic damping effect) should perfectly do.

The project should be adapted also as the branches cross sections are concerned. The Streicher's value of one square decimetre for each (fresh and exhaust air) one is lower limit, double cross-sections are better, to keep the velocities pronouncedly below 2 m/s. If possible, all the components should have such a generous size, incl. the fire valves and the heater. A suitable diameter for circular ducts would be 15 cm, but a solution without any pipes would be much better – using suitably divided false ceilings (from gypsum boards probably) of the central parts of the flats.

The project does not contain ducts to the pantry cupboards, pipes of an inner diameter of just 4 cm might do, see in more detail in the part Tightness and the Blow-door test.

Of course, even on the roof should be the ducts large enough, having approx. four times the cross-section given in the project.

There is no data on pressure drops on the proposed recuperators and some other components. Maybe, it will be necessary to choose another devices, ensuring velocities below 3 m/s.

1.2 The ventilation should be adjustable

The project goal to lower the heat losses so much, that no classic heating system is needed, is surely good. But as the project wisely includes letting one radiator inside each flat, we can think about the possibility than not all the heat load is to be always supplied just by the fresh ventilation air.

It has namely one unpleasant property: it has to run full strength just on those days, when it desirable to ventilate as little as possible, from a viewpoint of hygiene (and of energy savings). I mean the case of frosts, when the fresh air contains less than four grams of vapour in a cubic meter. After being heated to 22 degrees (a common temperature in passive houses, see e.g. Thür [3]) its humidity sinks below twenty per cent. But the ventilation is to rise the comfort, not to lessen it! By diminishing its rate in chilly weather the interior humidity can be raised to the beginning of the comfort range, at least to forty per cent – assuming somebody lives in the flat and so there are sources of humidity, as respiration (people themselves humidify the air from 20 to 40 %, if there are just $10\,\mathrm{m}^3$ of fresh air per hour and person).

By lowering the air exchange rate and the subsequent rise of humidity the inhabitants will perceive the interior temperature as suitable even if the air will have just $21\,^\circ\mathrm{C}$ instead of $22\,^\circ\mathrm{C}$, thanks to the diminished cooling of the skin by evaporation. Zdůrazněme, že ani Let's stress that even an incidental humidity around sixty per cent (entirely common in summer) cannot, in such a high-quality house, make any hygiene problems in winter, as there will be no cold surfaces where the water could condensate. Aside from getting a higher comfort, the fire risk will diminish**, when the humidity will be kept high** [this emphasised part has been missing due to my error in the first English and Czech drafts].

On the other side, the needed maximum heat input ($10\,\mathrm{W/m}^2$, i.e. 0.6 kW per a flat) may be easily supplied by a single radiator. Due to a missing thermal insulation inside a flat and a thanks to a thorough insulation of the building envelope, it is not very important where that radiator is placed.

Especially during a longer absence (winter holidays) it is suitable to reduce the ventilation of a flat, say to one tenth or even less, and to let some slight heating (not needed for the given flat, but considerate to the neighbours) to the radiator. The flux-reducing device can be mounted onto the outlets **and definitely on the bathroom exhaust air inlet** [this emphasised part has been missing due to my error in the first English and Czech drafts], or in need just centrally into the branch from the vertical duct. To put it on the outlets has a large advantage: it enables, e.g. at night, to ventilate generously just those rooms where somebody is sleeping in and to prevent drying another rooms in vain.

Controllable ventilation in the flats implies a necessity to regulate the power of the fans. The easiest regulation is to keep a constant pressure difference (against an outer air) in the main duct just before the recuperator. In this case the airflow in each flat will be independent on the ventilation settings in the other flats. The regulation will bring further electricity savings. The pressure difference can be centrally lowered when the temperature sinks below zero, to avoid the need to lower it individually in all the flats to reach some comfort level.

(Such a central reduction of pressure differences can be inappropriate just if there are smokers in some flat, who smoke in a room from which the air goes to another living places and the inhabitants want to dilute it by the fresh air as much as possible. During a diminished ventilation period they could do it by opening the windows, what should be quite exceptional and short-timed in a frost. So it is a topic to be further considered. **Maybe the experience shows what's the best strategy.** [this emphasised part has been missing due to my error in the first English and Czech drafts])

1.3 Central preheating of the air

One important preheating is missing in the project, namely the anti-freezing measure. The exhaust moisture should not freeze at the recuperator outlet. A bypass for the fresh air is another solution, but preheating can be simpler and more reliable. It's easy to make it by a a register using the freeze-resistant (solar) circuit. **It would have excellent efficiency, as the solar collector could have a working temperature of perhaps zero degrees...** [this emphasised part has been missing due to my error in the first English and Czech drafts]

On the other side, the heater on the outlet of the fresh air from the recuperator is very disputable. There is no need to heat the air to twenty degrees. At least at night it should be switched off, so that people who want to have a less warm bedroom could have a chance to get it, without opening the window (this should not happen, as it is reaction to overheating in fact). They can't get a cold air anyway, having a heat-recovery efficiency of 0.8 (if the recovery unit won't use a bypass as an anti-freeze measure), the least possible temperature is sixteen degrees.

The heating registers in the flats will be able to heat the air by thirty degrees, they will be able to heat it by thirty four as well when needed. But they need not, there will be a radiator in a flat. The simplest solution is therefore, to *abandon the central heating behind a heat recovery unit altogether*.

1.4 Solarwall

Preheating (or, sometimes the whole heating) of the air by the solarwall seems to be very low-efficient together with a good heat recovery. Really, from the heat gained by the solar wall just twenty per cent would be used most of the time. The full thermal gain could be used just as an anti-freeze protection of the heat recovery unit.

This is a large difference of the solar wall (a bored black sheet metal) from a warm-water collector. The gains of the latter one would be used completely in winter.

On the other side, the solar wall should have a comparable price to the common wall insulation – the present one contains mineral wool and sheet metal cladding as well. It won't be the case in this project probably, as there seems to be no producer of suitable bored sheets in Czechia. The solar wall at Oblá 14 should become an important impulse toward Czech enterprises to start with its production. For buildings without heat recovery, but with a mechanical ventilation, it is namely the best solution for the insolated facades, apart from the windows, with a short payback time.

Replacing the solar wall by using a hi-tech warm-water collector on the other side of the facade as well would be rather expensive. A lower insolation of the eastern half of the facade speaks against it as well, as it is almost half a day partly shadowed by a large tree – for cheap black sheets it's no pity (just it is necessary to place it at the eastern half of the facade).

In spite of that, considering all possibilities for the southern facade, I'm in favour of this alternative. Both continuous parts of the facade should be covered by a warm-water collector and just the cross-like areas between the windows should be covered by a Solarwall (like they are now, apart from the holes and black paint...). **To demonstrate a transparent insulation, just the lowest part of the middle section of the facade should do, or perhaps a lowest part of the eastern continuous area, instead of a water collector. The transparent insulation is not at all as efficient as a hi-tech facade water collector, with a comparable price, so the area covered by this way should remain small.** [this emphasised part has been missing due to my error in the first English and Czech drafts]

1.5 Humidifying bathroom?

A less significant topic is an installation of a circulation ventilator in a bathroom, which would blow the vapour usefully to the rooms in chilly periods, instead of discarding it to the exhaust air. It's again a comfort-beneficial measure. The bathroom air is often free of unpleasant odour, and to rise humidity with no cost is always good in winter. 60 % is better than 40 %.

During the cold periods the exhaust air inlet in the bathroom should be opened just in case somebody wants to use the bathroom as a quick drying room.

1.6 Tightness and Blow-door test

The basic condition of a functional and efficient ventilation with a heat recovery is, that all the air goes really through the recuperators. It means that there should be no other persistent ways for the air from the house and out of it, i.e., that the house should be tight otherwise.

It is never sufficient to assume it, but it's necessary to prove it. During such a proof, called a blow-door test, there are always some splits found and sealed. So long, that the air influx through then sinks below six tenths of an apartment volume in an hour, with a pressure difference of fifty pascals (see e.g. [4]), really achieved tightness is usually twice better.

HOWEVER, this conventional limit for passive houses (or for a suitability to use heat recovery) is quite insufficient for a multi-storey building like that on Oblá 14! Namely, in a cold winter period, the pressure difference between the outer and the inner air would amount to more than thirty pascals at the bottom floor. Most of the air would go in through the remaining cracks, instead of through the fresh heated air supply. Cold draft, lost of comfort and heat losses would result. Such a high building, with a central ventilation system, is to be at least thrice tighter. So the allowable limit is just 0.2 volume/h at 50 Pa. It holds both for the bottom storeys (greatest convectional air suction) and for the top ones (largest wind velocities). [this emphasised part has been missing due to my error in the first English and Czech drafts]

Because of the giant volume of the house it's recommendable to test each flat separately. And the bottom floor. At the end the tightness of the staircase is to be checked, i.e. of the all flat doors. These doors have to be very tight.

A blow-door test is an easiest proof if the house has been repaired without faults. It's especially important by such a plate concrete house, where the connection of panels are notorious for the cracks.

The holes to the pantry cupboards would make a great problem Their existence is in a sharp conflict with the idea of heat recovery. The openings through the building envelope, contained in the project, have to be abandoned. The cupboard is to be ventilated by a separate branch for the exhaust air – and as the presence of smokers near them is difficult to exclude, even the supply of fresh air should exist. Thin pipes, with a cross-section of just quarter of a square decimetre, should do.

When the ventilation system will be finished, an easy way of a tightness test is possible: by closing the fresh air supply. Just a way of measuring the airflow of the exhaust air should exist, a reasonable option even for the normal operation of the system. (Another airflow measuring device should be in the fresh air – in this way, inferring from the flow differences in freezy periods, any untightness in the bottom half of the building would be apparent.) [this emphasised part has been missing due to my error in the first English and Czech drafts]

1.7 Opening windows and inner insulations

... A suitable information would be a LED indicating that it's not suitable to let the windows open, fully or partly. It could be a part of a large display, reporting the middle temperature and humidity of the flat **and the same parameters of the outside air** [this emphasised part has been missing due to my error in the first English and Czech drafts], see further below. Two degrees of unsuitability could be given – the first saying that the heating runs or that it's too hot outside, the other warning that the energy losses through the untight window become substantial.

One of the reasons for opening the windows has been given already in the part on the disputability of the central heating of the air up to twenty degrees – namely the effort to cool down the bedroom. Apart from abandoning the central preheating, one other measure seems reasonable. It can but needs not be an integral part of the renovation. I mean adding some inner insulation. Up to now, the outer envelope has been so conductive, that the inhabitants of neighbouring flats could keep the inner temperatures quite different, according to their wishes. But by the thorough outer insulation the building will become almost isothermal, the thermal resistance of the ceilings and inner walls will become negligible. **Interestingly, it could lead to a loss of comfort for some people.** [this emphasised part has been missing due to my error in the first English and Czech drafts] The solution is to put some centimetres of insulating material on the walls and ceilings. **Even thick carpets could help a bit.** [this emphasised part has been missing due to my error in the first English and Czech drafts] Another option is insulating just the bedrooms, even from the surrounding rooms of the same flat. These insulations could be acoustic ones, as well.

Modular insulation (as some 1.5 m wide, in the whole height of the rooms) with a wooden frame and filled optimally by sheep wool (there are two certified Czech producers of woolen insulations), with a finished surface in various variants, according to the wish of the inhabitants, would be perhaps the best possibility. The inhabitants should have an offer to order and pay for it themselves. **If they know there are no differences of thermal preferences in the neighbouring flats at the moment, and no wish to have a cold bedroom, there's no need to install them now.** [this emphasised part has been missing due to my error in the first English and Czech drafts]

1.8 Roof room ventilation

The planned room for the new heat technology on the roof has mechanical ventilation in the project. This is obsolete, a convectional ventilation is completely sufficient, just in freezy periods it should be damped very much. If the occasional workers wouldn't feel well there, an open door and another opening at the opposite side (a window, even if the project says no windows) would change the air there in a moment.

2 Measurement and distributing the heating costs

In a house with a well insulated envelope there is no much sense in measuring the heat delivery to each flat, as far as the payments for it are concerned. In this way the inhabitants, whose neighbours try to have a lower temperature at home, would be penalised.

A fair accounting of the heat consumption, reflecting the true contribution of the flat to the total heat demand of the house, is just that one, which is based on the difference of inside and outside temperatures during the time when some heat is supplied. These temperatures are to be logged. Such a praxis has been described by M. Los [5] in the projects in Blansko (a town some 20 km N of Brno) in mid-nineties, with a pronounced decline in the building heat consumption and a maximum satisfaction of the inhabitants. Such an accounting virtually eliminates overheating (this system won a Grand Prix on Pragotherm 2003).

The condition for the system to work perfectly is that no windows remain unclosed in the house, i.e., the whole air from the flats flows through the heat recovery units. This is fortunately relatively easy to check, if the humidity is logged together with the temperature. Opening the windows in the cold period manifests itself by lowering the humidity in the flat.

Both values from electronic sensors, temperature and humidity, should be very apparently visible in each flat, the inhabitants should be able to see their history also. The collection of these data should be accessible (without recognising which flat is which) online on Internet as well, together with another values on the house operation.

The display in the flat could show another values as well, esp. temperature and ev. humidity of the outer air (the users of the southern flats have no possibility to measure in the morning resp. in the afternoon, as there is no place in the shadow). The difference of the outer and inner temperatures implies if opening the windows is OK or unsuitable (a separate indication of the same fact would be useful as well, see above).

3 I recommend better insulating and sophisticated windows

The project proposes windows with still rather large thermal transmissivity. For passive houses, there is a limit for a maximum specific transmissivity (a total one, incl. frames etc.) 0.8 W/(m^{2}K). Just when this is reached, there is no more need to have a radiator below them. The 1.1 W/(m^{2}K) value given in the project would result in unpleasantly cold window surface, which could be compensated just by an overheating. I know no way of advocating such a high transmissivity of the windows against an objection that it is an error in the pilot project.

It's possible to reach the usual limits for passive houses simply by a triple hi-tech glazing. For the frames, one possibility is their subsequent insulation of even the movable parts (the fixed ones should be insulated completely, not up to the remaining two centimetres, which were left uninsulated on the previously renovated houses, as on Obl Oblá 2). Another possibility is using such frames, which insulate enough themselves already.

But the triple glazing needs not be a standard one, filled all with krypton. Contrary to that, I'm in favour of a solution which a pilot project would deserve. I mean that the first cavity should be an air-filled one, with an aluminium Venetian blind, unpainted (!), moved even automatedly, electrically. The ideal blind would contain myriads of very small holes, so that the view through it in a closed state would be still possible. I saw such a kind on the Wels fair. By closing a blind overnight the passive house limit is easy to reach (assuming the second, interior cavity is the standard hi-tech one). At the same moment the escape of the light outside is prevented, what means more light inside and less light pollution outside.

Including the blinds into the project is necessary, as the main window area is not precisely southward, but the most inadvantageous eastward and westward one. These orientations causes overheating in summer. The only efficient remedy are just clear aluminium reflection surfaces, installed as outwards as possible. **If we won't choose the expensive possibility of outer "Rollades" (with unpainted Al surfaces again, of course),** [this emphasised part has been missing due to my error in the first English and Czech drafts] the blind should be in the outer cavity of a triple glazing, so that the sun-heated glass (each with a hi-tech layer of a low emissivity is heated a lot by sun) does not heat the interior.

4 Solar system discussion

is no polemics with the project, but its support... just the question of the planning of various surfaces on the southern facade is opened a bit.

.... (the translation of the following subsections is obsolete for readers with a profound knowledge of solar technologies).........,

4.1 A substantial part of each building is to be a solar collector

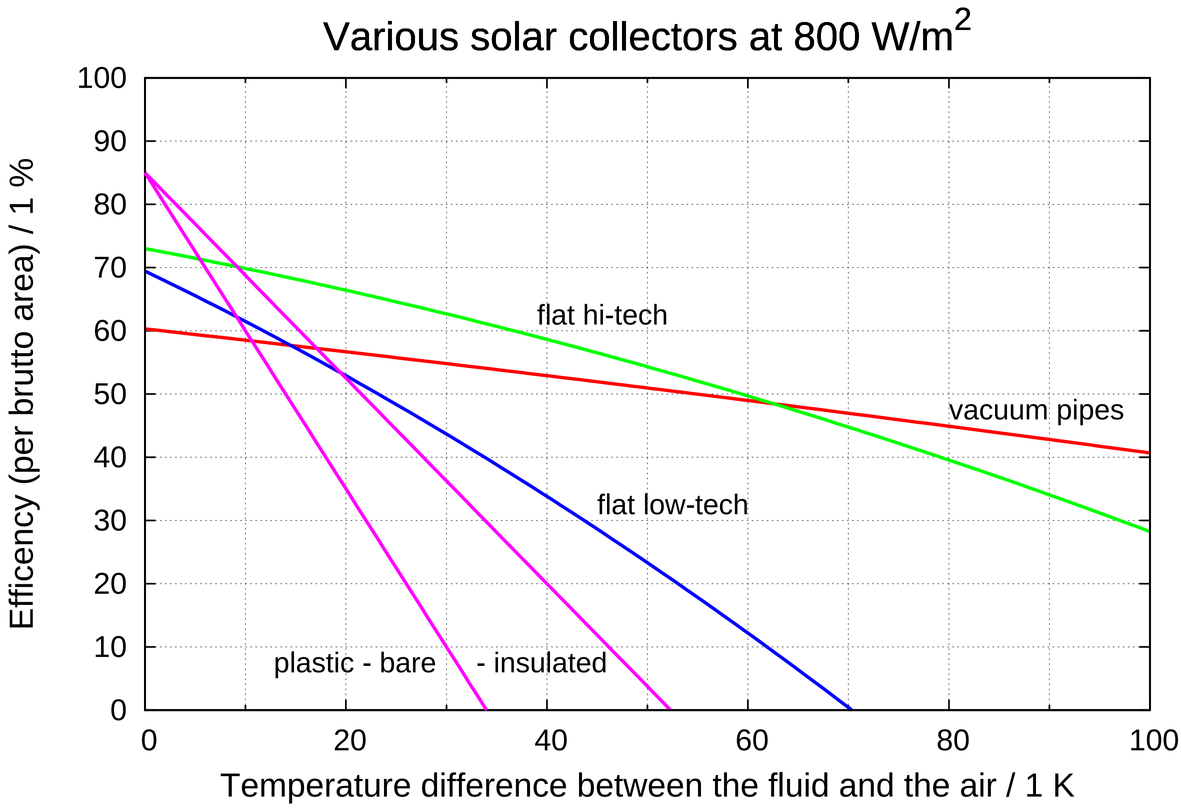
4.2 Costs, "Erträge", aesthetic kriteria

4.3 Dimensions and using the rest of the facade

4.4 Remark on the collector types

The business people in Czechia and Germany often claim, that "more heat can be obtained with vacuum collectors, esp, in winter",více tepla lze získat pomocí kolektorů vakuových, hlavně v zimě". This statement could hold in the times when no good selective absorbers were used (i.e. such ones, which cool little or just negligibly by radiation). Today such a sentence is not true a long time already. Heating of a potable water or building heating means using temperatures below sixty degrees, and from a given facade or roof area it is always possible to get more heat when it is covered by hi-tech flat collectors (with vacuum-process deposited dark films on absorbers and covered with a "solar glass" without an iron content). A graph illustrating this feature gives an efficiency of heating per brutto area of the collector.

The reason is that using vacuum tubes the maximum absorption area which can be placed on a given facade is rather low. The vacuum tubes could supply more heat just for working temperatures always over eighty degrees, it means for some other technology purposes. Of course not cheaper than flat collectors, because of their much higher price, vacuum tubes can be more economic just for working temperatures a lot over hundred degrees.



The graph is a synthesis of the data published by a solar test facility in the Swiss town Rapperswil [7]. It displays the roughly best types of flat and tube collectors. As for the low-tech collector, the data are taken from the first brochure by the Arsenal Research from Vienna (study [6] gives a higher efficiency of a low-tech collector, an unrealistic one in my opinion, with a "k" lower than 5 W/(m^{2}K)). For the bare absorbers, the author's estimates are shown (k or U 13 W/(m^{2}K), resp. 20 W/(m^{2}K)). Solarwall, i.e. the bored sheet metal, should have an efficiency close to the lowest curve, according to the link given in [2].

4.5 No heating of the warm water over 60 °C is needed

The project mentions a periodic heating of the water over 60 °C, as a prevention of legionellas proliferation. This is obsolete, a tight water pipeline system in Brno has always a chlorine surplus, which excludes a presence of bacteria. If the water temperature gets never over 60 °C, no mixing ventil is needed to save the users from getting boiled. (Apart from this, there can be doubts if heating below 80 °C sterilizes water substantially, but it's not important here.)

4.6 Remark on glasses

Solar collectors are assembled with e tempered glass of 4 mm thickness. It's something different from giant thick non-tempered glasses used as "glass facades". I've noticed a mention somewhere, that the supposed thickness is 8 mm, such a solar glass (without iron) does not exist maybe, and if it does, it would be very expensive (so as its holding in the place).

5 Thermal bridges

5.1 Balconies

There is no evaluation of the remaining thermal bridges in the projects. The most serious are the balconies, hanged still on steel components. They could be estimated by measuring the inner surface temperatures in the houses which are insulated already, but it would need cold outside temperatures. Computing them is not reliable due to the poorly known area of touch of the both components. There is no information on the materials, using the chrome-nickel steel with minimum thermal conductivity should be considered.

5.2 A roof over the entrance

The project claims that cutting away the current roof would be expensive. I guess that it is cheaper than hiding it inside a thermal insulation. Even when insulated, it would still be a large geometrical thermal bridge. The area before the entrance would profit from a new roof, much larger, just staying by the building. It might be translucent or transparent, with four columns. These could be useful for both bicycles and people...

6 Trifles

I'm not sure if in the "warm roof" alternative any expensive XPS insulation is needed, instead of EPS.

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