REFURBISHMENT OF MOIST BUILDING MASONRY IN TERMS OF SUSTAINABLE BUILDING

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Summary

Additional protection of older buildings against subsurface water and ground moisture is one of the most important measures to ensure their long durability and consequent minimum negative effect on the environment due to repetitive refurbishment action. There are number of methods for building additional protection against moisture. Resulting refurbishment action is usually more a set of these methods. The article analyzes various approaches in terms of sustainable building to outline such variants which are best for the maximal durability of the building and also include environmentally friendly technologies. Today the aspect of sustainable building is usually not taken into account during the design of refurbishment action – in most only the instantaneous price, regardless of the subsequent expenses of repetitive refurbishment action, is the decisive factor.

Keywords: refurbishment, moisture, remediation method, sustainability, masonry

1 Introduction

The additional protection of buildings against subsurface water and ground moisture is the most important measure to ensure its durability and thus also sustainability. In this paper, we will only deal with direct rehabilitation methods of substructure protection against moisture rising from the subsoil. The main task in this case is the interruption of capillary transport of liquid moisture in the masonry through an additional waterproof barrier or a significant increase in the evaporation of moisture from the surface of masonry.

2 Summary of the remediation methods

There are a lot of methods for additional protection of historic building against ground moisture and subsurface water [1, 2]. Five most common methods were selected for the comparison in terms of sustainability:

- **Plastic or bitumen coating** – the principle of this method is to place plastic (or bitumen) coating insulation into the slashed joint in the masonry. In case of brick masonry (considered in this paper), the joint in the wall can be created by an electric chain saw.
- **Metal sheets** – this method is based on profiled metal sheets (wave height is approximately 5 mm) which are driven into horizontal joints in the wall (only for

masonry with continuous horizontal joints). The driving is carried out by a special air hammer fixed on the rover.

- **Chemical infusions** – the principle of this method is a barrier created by injecting a chemical substance in to the masonry. The injection is carried out by pre-drilled holes in the masonry to which a solution is subsequently applied.
- **Electroosmosis** – the method is based on electroosmotic phenomenon whose principle is to create weak electric field between the electrode on the wall (graphite gird) and electrode in the adjacent soil (steel bar). The water molecules migrate to the soil electrode (out from the structure).
- **Air ducts** – this method is usually a set of two measures including ventilated wall (double wall with air void or channels in masonry) and ventilated floor (for example so called Iglu system). The principle of this method is to enable an air flow along the surface of moist structures and to ensure sufficient evaporation of moisture from the structure.

3 Sustainable additional protection against moisture

At the present usually the decisive criterion of the choice of remediation methods is only purchase price in relation to the expected effectiveness. In terms of sustainable building it is necessary to use the decision-making process based on multiple perspectives. Each remedial action must be subject to the following evaluation criteria:

- **Purchase costs** – this criterion can be divided to direct expenditure (purchase price of own remedial measure) and the associated construction and earthmoving work. Particular the price for associated earthworks may in some cases a significant effect on the overall price.
- **Running costs of measure –** the running costs and other additional expenditures necessary in throughout the life of measure is also important parameter of remediation method in terms of sustainability. Overall economic evaluation of remediation method should include purchase costs and running costs together.
- **Durability** – durability of building and construction is one of the most important sustainability criteria. Each remediation method can be considered sustainable only if it results in long-term durable effect (in our case, permanently dry construction). It is always necessary to consider whether the lower acquisition cost for remediation measure does not mean shorter service life and related higher overall costs in the future.
- **The risk factors in terms of technical efficiency** – the efficiency of each remediation method has a certain level of risk. Each building has specific conditions into which the measure will be installed. The level of risk depends on the quality of building technical survey but some methods have more risk factors than others.
- **The risk of building damage** – each remediation measure always means the interference in building structures. It carries a level of risk of structural damage and the associated additional costs of repair. The risk of damage depends not only on the measure but also on the character and condition of building structures.
- **The effect on the energy performance of the building** – because the aim of the rehabilitation measures is the drying of perimeter building structures, the impact on the energy performance of building for each method is always positive (lower

moisture level of structure equals lower thermal conductivity). However, the drying level of the structure may be different depending on the method used [3].

- **Impact on the environment** – there always exist a risk of the negative impact on the environment during the implementation of remediation measures. Some methods use a variety of chemicals or dusty technological procedures. The assessment of environmental impact must always be part of sustainable design of remediation measures.

4 Evaluation of methods in terms of sustainable buildings

The evaluation of selected remediation methods of older buildings against ground moisture according to the above mentioned criteria can be summarized as follows (Fig. 1):

- The additionally inserted plastic or bitumen coatings have higher risks of building damage and a significant negative impact on the environment during installation, but exhibit low running costs, show positive effect on energy performance of building and low risk factors in terms of technical efficiency.
- The metal sheets driven into masonry have higher initial costs and have slightly higher negative impact on environment during installation but show positive values for the other criteria.
- The chemical infusions have the most negative impact on environment due to the materials used and the durability and technical efficiency can be assessed as poor. Also, the risk of building damage during installation can not be omitted.
- Electroosmosis have high purchase value, very high running costs due to the constant electric consumption. Durability and technical efficiency can also be assessed as poor. The risk of building damage and impact on the environment is very low.
- Additionally constructed air ducts show mediocre purchase and running costs as well as durability and risk factors in terms of technical efficiency. Risk of building damage and impact on the environment are low, but the effect on energy performance of building is very poor.

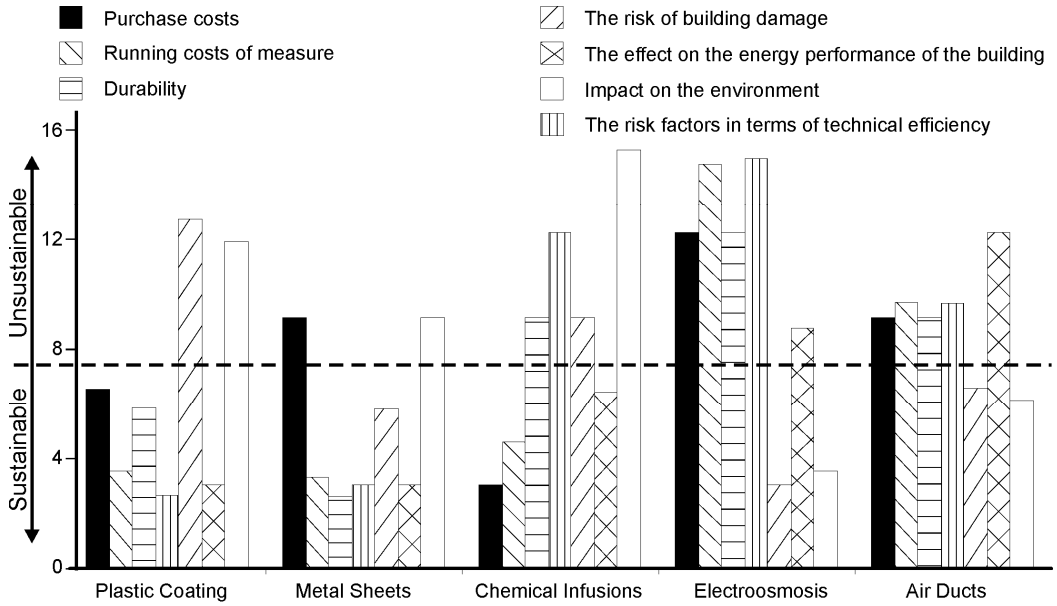

Fig. 1 *Comparison of methods according to evaluation criteria*

Value of individual criteria ranged from 1 to 15 and the values were determined on the basis of expert estimates or specific measurable parameters where possible.

5 Conclusions

The mechanical methods based on insertion of plastic or bitumen coating into subsequently created fissure and especially the metal sheets driven into masonry structures can be evaluated as the most sustainable methods of additional protection of old buildings against ground moisture.

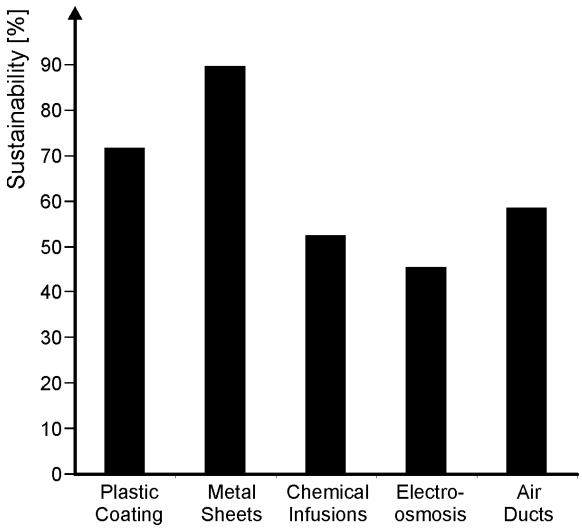

Fig. 2 *Sustainability of remediation methods against moisture*

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References

[1] BALÍK, M. *Odvlhčování staveb*, Grada Publishing a.s., Prague 2005, ISBN 80-247-0765-9.

[2] SON, L. H., YUEN, G. C. S *Building maintenance technology*. Macmillan, Houndmills, Basingstoke, Hampshire, 1993, ISBN 0-333-48993-4.

[3] PEJTER J., VANICKÝ, T., SOPOLIGA P., SEDLÁČKOVÁ M. *Udržitelný návrh a rekonstrukce budov*, Česká energetická agentura, 2006.