Compatibility issues regarding mortars for repairs and additions in interventions on historic masonry

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ABSTRACT

The functions of the materials used for interventions on historic fabric are multiple, and go beyond the plain repairing or completion of damaged parts or in need of strengthening. This is a significant reason (among others) due to which the recourse to original materials, traditional, or with otherwise akin properties, is not always enough.

In regard to the composition of mortars, reproducing the original recipes is often difficult. However, the existence of contemporary mortars based on hydraulic lime or trass, the composition and physico-mechanical properties of which are sufficiently known, reliable, and compliant with contemporary standards, allow for compatible interventions with good results in regard to rainwater protection. An effective mortar recipe depends on a clear understanding of its role in masonry, in respect of each of its functions. The technical requirements that a mortar must meet in order to be compatible with the historic fabric are mechanical strength, water absorption (absorption of water while in the state of immersion, capillary absorption and vapour permeability - each with different implications in regard to the physical behaviour of the masonry), adhesion the substrate, contraction, vibration resistance and freeze-thaw cycles.

The paper presents some guidelines regarding these compatibility issues and the decision factors that contribute to the design of contemporary compatible recipes of mortars for repairs and additions in interventions on historic masonry.

1. INTRODUCTION

Regarding interventions on historic masonry, one of the main objectives of the restorer must be to preserve as much of the existing material as possible - both for aesthetic reasons, and to perpetuate the documentary value of the structures on which the intervention occurs.

Nowadays, it is becoming increasingly clear that any intervention of preservation, consolidation, restoration and repair of historic masonry has limited durability and features signs of phisical wear and obsolence, so that, at the presenttime , any number of significant heritage buildings in Romania is facing a second or third round of interventions. It is inevitable that a certain amount of historical material to be lost irreversibly with each intervention. However, it is possible that the degradation to be channeled toward the new and less valuable material, this being one of the important goals of contemporary studies on the compatibility issues in the field.

An effective recipe of mortar relies on a clear understanding of its role within the masonry.

2. COMAPTIBILITY FEATURES

a. Mechanical strength

Mechanical strength has a significant weight among the qualities required of mortars with structural role, but it is not the most important feature.

In the absence of specific legislation, as is the case in Romania, normal values for mechanical resistance of mortar for masonry and values compatible with that of the historical masonry units may differ. Also, the hypothesis that lime -based mortars, hydraulic lime and cement mechanical resistance increases with age must be taken into account. After Ashurst [59] among the objections to the use of hydraulic limes, natural cements and Portland cement we find (1) high mechanical resistance, (2) impermeability and (3) the risk of salt transfer towards sensitive masonry materials.

1. Compatibility issues: higher mechanichal strength and impermeability in cement-based mortar: Romania, Cluj-Napoca, Str. Fortaretei. Foto (c) Ligia Andreica

b. Adhesion to the substrate

One of the most important features for both masonry mortar and plaster is the adhesion to the substrate. Adhesion between employment growth and increasing global mechanical resistance of masonry There is a relation of linear growth between adherence and the global mechanical strength of the masonry, relation that finds no correspondent in the increase of the mortar's mechanical strength [75].

c. Deformability: elasticity and contractility

Second in importance after the adhesion to the substrate, the low deformability of mortar for additions or repairs has a large share in limiting internal masonry applications, whether

contemporary or historical. Channeling the damage towards the adition mortars, which are disposable, can be controlled by adjusting the properties of elasticity and contractility.

2. Compatibility issues: Romania, Cluj-Napoca, Str. I.C.Bratianu (Foto: Ligia Andreica)

d. Behavior in the presence of water: absorption, vapor permeability, salt eflorescences

In terms of physics of the construction, historic buildings behave very differently from contemporary buildings, in the sense that vapor permeability is an essential, impossible to circumvent, feature of the historic building parts. Mortars with low capillary absorption, but permeable to vapors, are optimal in most situations.

Behavior in the presence of water can be modified by surface treatments or injection.

e. Durability: freeze-thaw resistance, vibration stress resistance

In regard to historical buildings, applying modern thermal insulating systems is completely inappropriate, and even when insulating plasters are employed, the problem of resistance to cycles of freezing - thawing remains a sensitive one. Also, in the case of stand-alone structures it gains bearing even more.

Regarding the vibration stresses, the issue is more acute now than a hundred or two years ago: high-density urban traffic brings not only pollution but also the constant stress of the microvibrations, whereas diverting traffic, desirable from the point of view of pollution is not always a viable solution.

3. Compatibility issues: cement-based pointing causing stone exfoliation: http://heritagehouse.twoclicks.co.uk/pages/damp-and-condensation/damp-problems-caused-by-cement-pointing-of-brick-or-stone.html

3. COMPATIBLE SOLUTIONS AND MATERIALS

Rebuilding / repairing materials can be, at best, similar in source and features.A special case, but circumscribed to this category, is that of visually recognisable reconstructions or replicas. Although they may involve materials that differ from those of the the original they shall respect the original design as closely as possible according to all available sources, whether physical or documentation.

Protective layers:

- Desiccant plaster;
- Application, impregnating, injecting of waterproofing substances;
- Continuing the masonry with contemporary compatible materials with protective properties;
- Vertical and horizontal waterproofing, applied on the surface, injected, or inserted;
- Roofing, roof structure subsets;
- Superstructures; separate coverage structures (as is the case for any of the numerous ruins whose degree of damage or specificity does not allow another type of protection)

For each intervention, compatibility properties and criteria differ to some extent. For example, in certain cases, historical coatings may have been employed for waterproofing, (Example – the historic "waterproofing" at Károlyi Castle in Carei, Romania). In these cases, the documentary value of the historical intervention must also be assessed and considered.

4. Historical waterproofing – with roof tiles –Károlyi Castle, Carei, Romania. (Foto Ligia Andreica)

5. Contemporary waterproofing –Károlyi Castle, Carei, Romania. (Foto Ligia Andreica)

Where there are or there have been historical protective coatings, they can be reconstructed or rebuilt, as far as their have proven effective. Ashurst [59] admits, in this respect, the continued use of a historic tallow and lime based waterproof mortar in a context where it was first put into practice, as for port and dock buildings, provided that the mortar is

properly protected with biocides, for example. On the other hand, in the case cited above, at the Károlyi castle from Carei historical vertical waterproofing, dating from the nineteenth century, proved ineffective and can be removed, as far as interest in the history of past interventions does not require that the least a part or a segment of it to be kept. Documenting the intervention (with photos and descriptions) remains, in any case, of significant interest for the history of the building technologies.

Layers added for aesthetic reasons count among them: plasters, reconstructed applications (replicas of stucco decorations made of molded polyurethane foam, for example) roofing materials aesthetically compatible but different from the original (eg scales tile colors that differ from the original or replacing a shingle roofing). Layers added for aesthetic reasons are essentially different from reconstructions, in that they claim no similarity to the original in regard to the material or, in most cases, the form and level of detail, and are intended only to complete the whole in an uncompromising formula in terms of authenticity. They can at the same time have a protective function, but the main role in this case remains the aesthetic one (and not the documentary one, as noted above).

4. CONCLUSIONS

Regarding the composition of mortars, restoring original recipes is often difficult. However, the existence of contemporary mortars based on hydraulic lime or Trass whose composition and physico-mechanical properties are sufficiently controlled, and *can* satisfy *contemporary standards, allow* compatible interventions with good results *in regard to* rainwater protection.

A good knowledge of the role and function of the mortars within masonry is a necessary requirement in terms of obtaining highly compatible recipes and means of intervention.

The preservation of the original materials and the proper documenting of each intervention is of paramount importance, esepcially in the case of structures that suffered multiple previous interventions.

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