Journal of Cultural Heritage xxx (2017) xxx–xxx

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MODIHMA 2018

Efficiency evaluation of treatments against rising damp by scale models and test *in situ*

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ARTICLE INFO

Article history:
Received 1st February 2018
Accepted 26 March 2018
Available online xxx

Keywords:
Climate change
Chemical injection
Dehumidification plaster
Moisture content

ABSTRACT

The presence of water in masonries is one of the most relevant cause of decay in historic buildings. If water is present, particularly rising damp, degradation processes such as biological growth, powdering due to salt crystallization cycles may arise and be intensified. Treatment against rising damp is therefore generally advised for the protection and preventive conservation of historic buildings. Within this framework, the JPICH Project "Effectiveness of methods against rising damp in buildings: European practice and perspective – EMERISDA" (2014–2017) aimed at a scientifically based evaluation of the effectiveness of different methods against rising damp and at decision support tool definition for a conscious choice use of these methods in the practice of conservation. During the present paper the methodology adopted on site for the evaluation of the efficiency of methods aiming at stopping/limiting rising damp on masonries is described. Specifically, results concerning the treatments on masonries with chemical injections (solvent and water based) and with plasters application on scale models and the case study of Agorà in Ferrara (Italy) are presented.

1. Introduction

Rising damp is surely the most widespread phenomenon leading to moisture presence in masonries and it severely threatens both performance and conservation of historic and contemporary buildings. The high moisture content deriving from the presence of rising damp does not only create an unpleasant climate in a building with direct consequences on the health of the inhabitants, but it also considerably enhances deterioration processes in building materials in walls such as plaster detachment, mould formation, powdering and decohesion due to freeze-thaw cycles and salt crystallization.

Due to climate changes including sea level rise, variations in the ground water level and increased frequency of extreme events (flooding, episodes of intense rain), the relevance of the effects due to rising damp is expected to increase in the near and far future [1–4].

Even though treatment against rising damp is generally recommended and despite the great offer of specific products in the market, the methods applied in the field unfortunately still often fail [5]. Indeed, a scientific approach to identify the origin of the problem based on a proper diagnosis and a monitoring of the effectiveness of treatments over time are still nowadays missing. The JPICH EMERISDA Project aimed purposely at filling this gap by providing a comparative evaluation of existing techniques and by developing guidelines for the user to determine the best solution for each case of damage due to rising damp [6–8]. This objective has been achieved by sharing the knowledge diffused across Europe and by acquiring new knowledge through the application of selected methods *in situ*. Specifically, historic buildings, churches and examples of industrial heritage have been chosen as case studies in Netherlands, Belgium and Italy: St. Bavo's church (Haarlem), Paardenmarkt (Delft), St. Martin's church (Genappe), Antwerp Saint Felix Warehouse, Basilica di San Marco (Venice) and a former sugar factory complex (Ferrara, Italy). In addition, scale models have been purposely set up in real environment for one year at the research area of the National Research Council of Italy in Bologna. In the present contribution results obtained on the treatments with chemical interruption and plasters application tested at the case study in Ferrara and at the scale models in Bologna are discussed, focusing mainly on the methodological approach applied *in situ* for the diagnosis of the presence of rising damp and for the evaluation of the effectiveness of the applied treatments.

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https://doi.org/10.1016/j.culher.2018.03.020
1296-2074/

Table 1
Selected treatments for application.

Method	Commercial name	Application details/additional information
Chemical interruption: Siloxane, liquid, organic solvent based, injection under low pressure	BSO 166/7 R Produced and commercialised by Chem Spech	Product to be injected in • Holes of 10 mm diameter • Distance between holes is 100 mm • Plaster Façade • Depth: 30 cm and 55 cm (thickness of the wall 70 cm) Injection under low pressure, about 4 bar. The product is ready-to-use. www.chemspec.it/prodotti/idrorepellenti/idrorepellenti-a-base-solvente/bso-1667/
Chemical interruption: Silane-siloxane, liquid, zero VOC, in water, low pressure	VP1785 Produced and commercialised by Chem Spech	Product to be injected in • Holes of 10 mm diameter • Distance between holes is 100 mm • Plaster Façade • Depth: 30 cm and 55 cm (thickness of the wall 70 cm) Injection under low pressure, about 4–6 bar. The product is not ready-to-use, it should be diluted with water until a concentration of 10% is reached Solution stability: 5–6 months Serbatoio a pressione con aria compressa www.chemspec.it/prodotti/barriera-chimica/vp-1785/
Chemical interruption: Silane-siloxane, liquid, organic solvent low VOC, low pressure	Barsylan100 Produced and commercialised by Chem Spech	Product to be injected in • Holes of 10 mm diameter • Distance between holes is 100 mm • Plaster Façade • Depth: 30 cm and 55 cm (thickness of the wall 70 cm) Injection under low pressure, about 4 bar. The product is not ready-to-use, it should be diluted with water until a concentration of 10% is reached. Solution stability: 6–8 h www.chemspec.it/prodotti/barriera-chimica/barsylan-100/
Dehumidification plaster: Dehumidifying premixed product fibre-reinforced with cork (gran. 0–4 mm), clay, natural hydraulic lime NHL 5, diathomaceous earth.	Diathonite deumix Produced and commercialised by Diasen srl	*Diathonite Deumix* has to be applied following this steps: 1. The product has to be mixed with 11–12 l of water per bag of Diathonite Deumix (20 kg) using a drill mixer. 2. Wet the substrate before the application. 3. Prepare the area creating the reference bands to obtain 2.0 cm of thicknesses and apply *Diathonite Deumix* in just one coat. 4. Prop and smooth. 5. At 20 °C and with relative humidity level of 40%, the product dries completely in 15 days. While drying protect *Diathonite Deumix* plaster from ice, direct sun light and wind. With high temperature, direct sunlight or strong wind it is necessary to wet the plaster 2/3 times per day for the next 2/3 after the application. *Diathonite Deumix* can be applied also with a plastering machine for premixed plaster. www.diasen.com/sp/en/p/diathonite-deumix.3sp
Dehumidification plaster: Step 1 – Dehumidifying regularization with anti salt barrier properties. Premixed mortar based on natural hydraulic lime and mineral additives selected with a suitable granulometry (0.5–1 mm). Step 2 – Dehumidifying premixed product fibre-reinforced with cork (gran. 0–4 mm), clay, natural hydraulic lime NHL 5, diathomaceous earth.	Produced and commercialised by Diasen Srl 1 Diathonite Rinzaffo 2 Diathonite Deumix	Step 1 – *Diathonite Rinzaffo* has to be applied following this steps: 1. Mix *Diathonite Rinzaffo* with 15–20% of clean water, 4–5 l each bag (25 kg). Gradually add the powder. The mixing can be done in a concrete mixer or in a bucket (by hand or with a drill mixer at low speed) until obtaining a homogeneous mixture without lumps. 2. Wet the surface with low pressure water up to saturation. 3. Apply a coat of 0.5 cm of *Diathonite Regularization* by trowel. 4. Once the application has finished, smooth the product in order to obtain a levelled surface. 5. Trowel *Diathonite Rinzaffo* with a sponge trowel. We suggest to trowel the product if pushing your hand on top of it you leave just a slight fingerprint. A correct trowel allows to avoid cracks. 6. To improve the curing of the product, if possible, apply a polyethylene sheet for about one day after the application, to keep a high humidity or wet the product until it is completely dry. 7. At 20 °C and with relative humidity level of 40%, the product dries completely in 1 day. While drying protect *Diathonite Deumix* plaster from ice, direct sun light and wind. With high temperature, direct sunlight or strong wind it is necessary to wet the plaster during the first 24 h. *Diathonite Rinzaffo* can be applied also with a plastering machine for premixed plaster. Step 2 – *Diathonite Deumix* has to be applied as previously described

2. Experimental approach

2.1. Treatments applied

On the basis of the overview of existing solutions against rising damp and definition of the procedures and criteria for the evaluation of their effectiveness defined at the beginning of the EMERIDA Project, the methods to be tested at the case studies and scale models have been chosen. The selected treatments for application *in situ* both at the case study in Ferrara and at the scale models in Bologna are described in Table 1, alongside their commercial name and the technical information for their application.

2.2. Moisture content measurement

The effectiveness of the treatments selected and applied *in situ* to stop or mitigate rising damp has been assessed by comparing the

Please cite this article in press as: A. Sardella, et al., Efficiency evaluation of treatments against rising damp by scale models and test *in situ*, Journal of Cultural Heritage (2017), https://doi.org/10.1016/j.culher.2018.03.020