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INTERNATIONAL COUNCIL ON MONUMENTS AND SITES

1<sup>st</sup> Meeting of the National Scientific Committee on Energy and Sustainability (NSCES)  
10<sup>th</sup> March 2015, 5.45pm for 6pm start  
Australian Institute of Architects, Tusculum, 3 Manning Street, Potts Point

### 9.1.2 Energy Efficiency in Historic Buildings, Madrid update

International Conference on Energy Efficiency in Historic Buildings: Experiences & Solutions - How to improve the energy efficiency of historic buildings while preserving their historic character, values and historical integrity - 29 & 30 September 2014



Conference location; Escuela Técnica Superior de Ingenieros Industriales, Madrid

The conference was an international forum that aimed to give visibility to groups working on the generation and transfer of knowledge on energy efficiency applied to historic buildings. Sponsors and collaborators included: Spanish Ministry for Economy, Spanish Foundation for Science and Technology, Edinburgh World Heritage and the Austrian Ministry for Transport, Innovation and Technology.

<http://www.energy-heritage.com/>  
<http://www.energy-heritage.com/en/>

The themes of the conference were:

- Traditional and technical knowledge: concepts, techniques, practices, uses, materials, methodologies
- Governance, management, participation and mediation
- Legal and technical regulation and historic buildings
- Funding mechanisms

Over 170 people from 18 countries participated in the conference, sharing research and case studies. Whilst the focus was on ideas to assist property owners in meeting European Union and European

Community targets for energy use and efficiency, case studies and research from across the world was presented at the conference. Papers ranged from case studies of towns, e.g. Porto, Portugal with an historic centre largely in the ownership of non-wealthy citizens through to studies modelling embodied energy, the use of photovoltaics in villages along the Camino de Santiago de Compostella and issues in providing comfort for infrequent (once a week) but loyal and devoted congregations of churches. All proceedings and papers were captured by the conference organisers and can be found at <https://energyheritage.files.wordpress.com/2014/12/actas-proceedings-energy-efficiency-and-historic-buldings1.pdf>

Members of NSCES may be familiar with many of the challenges and ideas canvassed at the conference but I was particularly struck by the complexity of the issues faced by EU member states to meet common legislative requirements and energy use targets within their own cultural and political environments. I was also interested in the work being done by the Sustainable Buildings Network UK, a collaboration of not-for-profit organisations that aims to promote and deliver a more sustainable traditional built environment in the UK <http://stbauk.org> who have a terrific tool <http://responsible-retrofit.org/wheel/> which though very much geared towards the UK's heritage/conservation system provides an interesting idea for a tool that could be adapted for Australian use.

I presented a recent boiler replacement project at Old Parliament House Canberra and explored the Australian Government imperatives to meet energy efficiency targets, described the varied technical, conservation and regulatory challenges of the project and finished with some data that is showing that the innovative solution is already demonstrating energy savings. At the end of the project we have emerged with values intact and a heating system that will ensure the heritage site has a sustainable future.

Edwina Jans

Member, NSCES (National Scientific Committee for Energy and Sustainability, Australia)

*(See following pages for Samples of poster presentations at conference)*

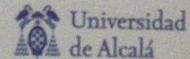


# LIME-CEMENT MORTAR WITH IMPROVED THERMAL AND ACOUSTIC CHARACTERISTICS FOR REHABILITATION

Programa **Geo** Materiales  
Conservación del Patrimonio

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## INTRODUCTION & OBJETIVES

The rehabilitation of buildings often requires the restitution or substitution of coating mortars, due to their deterioration. Many old buildings are characterized by large energy consumption and a low noise control, according to today's thermal and acoustic standards. Thus, habitability improvement has become a main concern of rehabilitation techniques and materials. This poster presents an experimental program to design a pigmentable lime-cement coating mortar, for both indoors and outdoors application, with improved thermal and acoustic performance, for repair, rehabilitation or new buildings.

## MATERIALS & METHODS

To achieve functional, technical and thermal and acoustic requirements on lime-cement mortars, a gap-graded aggregate (GGA) and low amounts of lightweight aggregates (LWA) or fibers (F) were used (Fig.1). The binder combined aerial lime (L) and white cement (C) in order to: accelerate lime setting-time, improve lime mechanical performance, reduce pathologies related to cement's alkalis content and allow colored mortars (Fig.2).

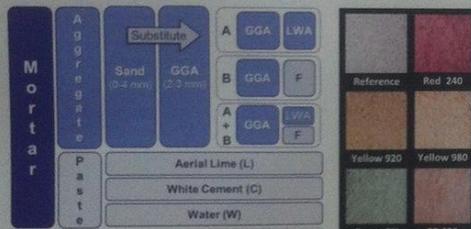


Figure 1. Composition design of lime-cement mortar



Figure 2. Colored mortar

The experimental program assessed the fresh state (consistency, free shrinkage and initial time), hardened physical properties (apparent density and open porosity), mechanical performance (compressive, flexural and adhesion strength) and thermal and acoustic behavior of twelve lime-cement mixtures (Fig.3).

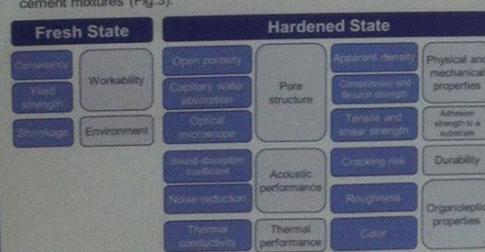


Figure 3. Experimental program: measurement and assessment

## CONCLUSIONS

The main goal is, therefore, to set an experimental methodology and benchmarks to design and characterize a coating mortar for its use in rehabilitation, improving sound absorption coefficient, reducing sound reflection and avoiding noise problems, and thermal conductivity, enhancing thermal insulation. In addition, the apparent density and mechanical and adhesion strength achieved allowed their use as finishing materials.

## REFERENCES

[1] Palomar, I. & Barluenga, G. (2014). Pigment. Mezcla de cal y cemento con características térmica y acústica. Spain, Application number P2014-00305 Madrid, Spain: OEPM.

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[3] Silva, L., Ribeiro, R., Labrincha, J. & Figueira, V. (2010). Role of aggregate form on the properties of a novel binder mortar. Cement & Concrete Composites, 32, 19-24.

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## RESULTS

### Thermal & Acoustic Performance

Some mixtures reduced the thermal conductivity under 0.20 W/mK or increased the noise reduction coefficient over 0.10 (Fig.4). A parametric analysis allowed the identification of some relations among thermal conductivity, noise reduction coefficient and pore structure (Fig.5).

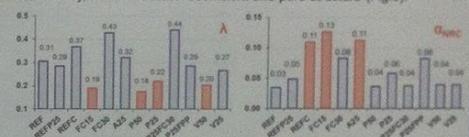


Figure 4. Thermal conductivity ( $\lambda$ ) and noise reduction coefficient ( $\alpha_{w,c}$ ) of lime-cement mortars

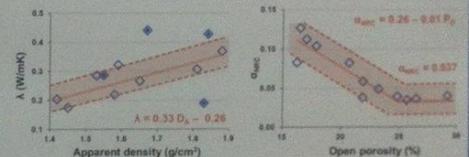


Figure 5. Relations among thermal conductivity, noise reduction coefficient and pore structure

### Hardened Performance

The changes in composition modified the pore network and structure (Fig.6). Five samples out of twelve cracked, and the total cracked area was maximum on REF (Fig.7).



Figure 6. Optical micrographs

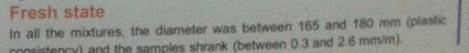


Figure 7. Cracked samples (390 x 390 mm)

### Fresh state

In all the mixtures, the diameter was between 165 and 180 mm (plastic consistency) and the samples shrank (between 0.3 and 2.6 mm/m).



Congreso Internacional  
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**Eficiência Energética e Reabilitação Urbana de um Centro Histórico classificado pela UNESCO: o caso do Porto**  
Autores: Álvaro Sanjos, Paulo Vilhena, José Serqueira

O Porto Vivo, SRU promove a reabilitação de património degradado e, de entre as primeiras intervenções, destaca o desenvolvimento do "Guia de Termos de Referência para o Programa Energético Ambiental" de forma a melhorar a eficiência energética dos edifícios, realizado com a Faculdade de Engenharia e com a Direcção Regional de Cultura do Norte.

Elaborar um protocolo edilício é reabilitar e conservar a identidade urbana e arquitectónica, mas é também criar espaços habitáveis contemporâneos para pessoas e actividades. Há que ser cuidadoso na intervenção sobre o edifício, mas há que apoiar nos conceitos de conforto que, no século XXI, se aliam com os edifícios antigos. Reabilitar património não pode ser uma actividade conservadora, mas sim algo que necessite não só de criar a estética, e desde então, as questões técnicas e de eficiência energética e de sustentabilidade têm um valor muito importante.

O desenvolvimento deste tipo de intervenções em património classificado é complexo, pelo que o Porto Vivo, SRU desenvolveu, no âmbito do Projecto C2D Europeu, financiado pelo Programa URBACT II, uma proposta de fundo de tipo JERMIKA que pretende apoiar a reabilitação de edifícios privados de função predominantemente habitacional. Trata-se de um dos eixos do Plano de Acção Local, em desenvolvimento, que poderá vir a constituir um instrumento replicável em outros contextos europeus.



**Eficiencia Energética y Rehabilitación Urbana de un Centro Histórico clasificado por la UNESCO: el caso del Oporto**  
Autores: Álvaro Sanjos, Paulo Vilhena, José Serqueira

Porto Vivo, SRU promueve la reabilitación de patrimonio degradado, y entre las actuaciones realizadas, destaca el desarrollo del "Guía de Términos de Referencia para el Programa Energético Ambiental" con el fin de mejorar la eficiencia energética de los edificios, realizado con la Facultad de Ingeniería y la Dirección Regional de Cultura.

Elaborar un protocolo edilicio hoy en día es reabilitar y conservar la identidad urbana y arquitectónica, pero también crear espacios habitables para las personas y actividades de hoy. Debemos ser cuidadosos en la intervención en el edificio, pero debemos apoyar en los estándares de confort que, en el siglo XXI, se unen con los edificios antiguos. Reabilitar patrimonio no puede ser una actividad conservadora, sino algo que ayude a valorar sin deteriorar lo antiguo, y en este sentido, las cuestiones técnicas y de eficiencia energética y las cuestiones de sostenibilidad tienen un valor muy importante.

El desarrollo de este tipo de intervenciones en patrimonio clasificado es complejo, por lo que Porto Vivo, SRU ha desarrollado, por referencia del Proyecto C2D Europeo, financiado por el programa URBACT II, una propuesta de fondo de tipo JERMIKA que tiene como objetivo apoyar la reabilitación de edificios privados de función predominantemente residencial. Es una de las acciones del Plan de Acción Local, en desarrollo, que puede ser un instrumento replicable en otros contextos europeos.

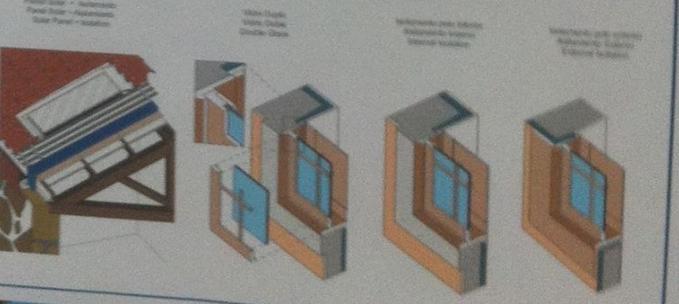


**Energy Efficiency and Urban Renewal of a UNESCO-listed historical center: The case of Porto**  
Autores: Álvaro Sanjos, Paulo Vilhena, José Serqueira

Porto Vivo, SRU promotes the rehabilitation of degraded heritage, and among the established interventions, it includes the development of the "Guide of Terms of Reference for the Environmental Program" in order to improve the energy efficiency of buildings.

Rehabilitating built heritage includes rehabilitation and conservation of the urban and architectural identity, but also recreation of the living spaces for people and activities of today. There should be caution in the intervention of the buildings, but it's necessary some comforted as far as the comfort conditions are concerned that in the 21st century building users require. Heritage cannot be a conservative activity, but something that adds value without disturbing the antique, and in this context, heating and energy efficiency issues as well as sustainability issues have a very important value.

The planning of these types of interventions in classified heritage is complex, so Porto Vivo, SRU developed, under the C2D Europe Project, financed by the URBACT II programme, a proposal of funding process that aims to support the rehabilitation of private buildings predominantly residential. This is one of the actions of the Local Action Plan, under development, which may become an instrument replicable in other European cities.



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Sample of poster presentations at conference



## TECHNICAL SYSTEM HISTORY AND HERITAGE: A CASE STUDY OF A THERMAL POWER STATION IN ITALY

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### INTRODUCTION

Energy efficiency and sustainability in Heritage Buildings (HB) are closely related to the history of buildings.

i) the study of *Historic Indoor Microclimate (HIM)*, defined as the non-material part of a building, or, in other words, the "*Environmental Building*" (EB).

ii) a study of technical systems - hydraulic, wiring, HVAC, etc. - whose main role is to guarantee and to satisfy the above indoor comfort set-points.

The study of the technical system framework presents four items:

- historical items**, in order to find out if existing systems have an historic relevance for specific building history and/or History of technology;
- technical systems surveying**, in terms of both building surveys in order to know their network system (e.g. air-conducts, pipelines, etc.), front-end emission (e.g. radiator, light, fan-coil, etc.);
- effectiveness** of operation of historic technical plant, that depends on a specific technical plant, in spite of a wide variety of technical systems;
- the **heritage preservation** of technical system as documents, and/or technical system integration in order to guarantee modern-day comfort set-point conditions.

*In our point of view, if during restoration an architect understands the above four items of the conceptual framework, he should propose a better way to improve energy efficiency in the heritage building.*

### THE CASE STUDY: THERMAL POWER STATION

The Thermal Power Station of ITIS Giovanni Marconi (Secondary Technical School) located in Forlì in the center-north of Italy. The Thermal power station was built in 1938 and is the same age of building.

The Historic Thermal Power Station - a museum in itself - is a small Rankine Cycle, with a boiler with a horizontal Babcock-&-Wilcox water-duct, produced by Officine Breda Elettromeccanica e Locomotive spa, an industry with a major role in the Italian industrial history during the XIX and XX centuries.



Boiler with horizontal Babcock-&-Wilcox water-duct



Turbine (left) and Alternator (right)



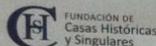
Condenser (under turbine)

This little piece of Industrial Archeology is fascinating, for these reasons:

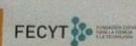
- it is a document of a Rankine Cycle and Babcock-&-Wilcox technologies in Italy;
- the educational role for Technical Institute students, they in turn would perhaps have been able to construct or to manage similar power stations;
- the independent decision, from WWII to today, to preserve the Thermal Power Station as a document, as a teaching example

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