



Book of Abstracts of the
International Fire Safety
Symposium 2015

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**cib - International Council for Research and
Innovation in Building Construction**
UC - University of Coimbra
albrasci - Luso-Brazilian Association for Fire Safety

Editors:

João Paulo C. Rodrigues
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Authors:

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PREFACE

On behalf of the Organising and Scientific committees, as well as the CIB W-14 Commission on Fire Safety it is our pleasure to welcome you to the International Fire Safety Symposium - IFireSS 2015, which is organised by the CIB's Commission W14-Fire Safety, ALBRASCI and University of Coimbra. The Symposium aims to contribute to the exchange of ideas and knowledge in the area of Fire Safety and assist in planning future research activities in this area.

CIB W14-Fire Safety is a Working Commission of CIB (International Council for Research and Innovation in Building & Construction) and its main objectives are:

- To create an ongoing research and innovation focus for the development of a comprehensive, coherent, rational and empirical basis for a safe and sustainable built environment, which includes fire science and engineering practices and design methodologies;
- To promote the acceptance of Fire Science and Engineering Practices, Procedures and Design Methodologies worldwide, and to encourage their use in Building and Fire Safety Legislation, Codes, Regulations and Standards;
- To provide technical input, from a Fire Science and Engineering Perspective, to other relevant CIB Working Commissions and Task Groups;
- To facilitate the transfer of state-of-the-art Fire Science and Engineering Technology at international level;
- To encourage capacity building for Fire Science and Engineering worldwide.

The Luso-Brazilian Association for Fire Safety (ALBRASCI) was established recently by Portuguese and Brazilian specialists in the area of Fire Safety to create a platform for the development of Fire Safety in Portugal and Brazil.

The University of Coimbra (UC) is a reference in higher education and research in Portugal, due to the quality of the courses taught and to the advances achieved in pure and applied research in various areas of knowledge. UC is also well-known around the World due to the research and training in Fire Safety with an MSc and PhD in the area.

The Symposium has participants from researchers around the world and covers a wide variety of research areas including: Structural Fire Safety; Mechanical and Thermal Properties of Materials; Fire Chemistry, Physics and Combustion; Fire Reaction; Fire Safety in Vehicles and Tunnels; Fire Risk Assessment; Smoke Control Systems; Firefighting and Evacuation; and Fire Regulations, Standardization and Construction Trends.

Joao Paulo C Rodrigues
President of the Organizing Committee

George Hadjisophocleous
President of the Scientific Committee

CONTENTS

FIRE SAFETY OF STRUCTURES

LOCALIZED FIRE TESTS ON THE STEEL COLUMNS FOR DIFFERENT CROSS SECTION AND CEILING CONDITIONS

Ali Nadjai, Sanghoon Han, Vassart Olivier and Obiala Renata

.....3

NUMERICAL MODELS OF COLD FORMED STEEL COLUMNS MADE OF SQUARE TUBULAR SECTIONS SUBJECT TO FIRE

Wagner C. Rocha, Tiago A. Pires and José J.R. Silva

.....7

SHEAR BUCKLING EVALUATION IN STEEL PLATE GIRDERS WITH NON-RIGID END POSTS SUBJECTED TO ELEVATED TEMPERATURES

André Reis, Nuno Lopes and Paulo Vila Real

.....11

PARTIALLY ENCASED SECTION: STRENGTH AND STIFFNESS UNDER FIRE CONDITIONS

Paulo Piloto, David Almeida, A.B Ramos-Gavilán and Luís M.R. Mesquita

.....15

RECENT APPLICATION OF EN1993-1-2 IN GERMANY

Martin Mensinger, Florian M. Block, Christian Maershofer, Rudolf O. Reisch and Walter Borgogno

.....19

TEMPERATURES IN BLIND-BOLTS CONNECTIONS TO HOLLOW AND CONCRETE FILLED TUBULAR COLUMNS

Ana M. Pascual and Manuel L. Romero

.....23

EXPERIMENTAL INVESTIGATIONS ON THE THERMAL AND MECHANICAL BEHAVIOUR OF COMPOSITE COLUMNS WITH MASSIVE STEEL CORE IN FIRE

Peter Schaumann and Inka Kleiboemer

.....27

FIRE BEHAVIOR OF COLD FORMED COLUMNS – EXPERIMENTAL TESTS <i>Waghner C. Rocha, José J.R. Silva, Tiago A. Pires and Leonardo M. Costa</i>	31
FIRE REACTION OF CONCRETE WITH AND WITHOUT PP FIBRES: EXPERIMENTAL ANALYSIS AND NUMERICAL SIMULATION <i>Paulo Piloto, Luís M.R. Mesquita and Carlos Balsa</i>	35
EXPERIMENTAL INVESTIGATION ON THE BEHAVIOUR OF COLD-FORMED STEEL COLUMNS SUBJECTED TO FIRE <i>Hélder D. Craveiro, João P. Rodrigues and Luís Laím</i>	39
INCLINED COAL HANDLING BRIDGE AFTER FIRE <i>Kamila Horová, Petr Hejtmánek, Slavomír Entler and František Wald</i>	43
IN-PLANE LOADED CONCRETE SLABS SUBJECTED TO FIRE: A NOVEL TEST SET-UP TO INVESTIGATE SPALLING <i>Francesco Lo Monte, Roberto Felicetti, Chiara Rossino, Alessandra Piovan and Gabriele Scaciga</i>	47
BEHAVIOR OF A STEEL-CONCRETE JOINT UNDER A ROBUSTNESS SCENARIO - INFLUENCE OF THE BEAM SPAN LENGTH AND THE BEAM AXIAL RESTRAINT <i>Cécile Haremza, Aldina Santiago and Luís Simões da Silva</i>	51
BEHAVIOUR OF UNPROTECTED AND PROTECTED CELLULAR BEAMS HAVING DIFFERENT OPENING SHAPES IN FIRE CONDITIONS <i>Ali Nadjai, Sanghoon Han, Faris Ali, Klelia Petrou, El Hadi and Ali Naili</i>	55
INFLUENCE OF HEAT AND MASS TRANSPORT ON MECHANICAL BEHAVIOUR OF TIMBER ELEMENTS IN FIRE <i>Robert Pečenko, Staffan Svensson and Tomaž Hozjan</i>	59

<p>BOLTED TIMBER CONNECTIONS UNDER HIGH TEMPERATURES <i>Eduardo Schneid, Carolina da Rosa and Poliana Dias de Moraes</i></p> <p>.....</p>	63
<p>PARAMETRIC STUDY ON COLD-FORMED STEEL COLUMNS MADE WITH OPEN CROSS-SECTIONS SUBJECTED TO FIRE <i>Hélder D. Craveiro, João P. Rodrigues and Luís Laím</i></p> <p>.....</p>	67
<p>ACCURACY OF AVAILABLE ANALYTICAL MODELS FOR FIRE DESIGN OF COLD-FORMED STEEL OPEN FLEXURAL MEMBERS <i>Luís Laím, João P. Rodrigues and Hélder D. Craveiro</i></p> <p>.....</p>	71
<p>INFLUENCE OF INDUSTRIAL FAÇADES AND TRAPEZOIDAL SHEETING ON STEEL MEMBERS WITH INTUMESCENT COATING <i>Martin Mensinger and Peter Kraus</i></p> <p>.....</p>	75
<p>VERIFICATION OF WEB TAPERED BEAM-COLUMNS IN CASE OF FIRE USING THE GENERAL METHOD OF EUROCODE 3 <i>Carlos Couto, Pedro Duarte, Paulo Vila Real and Nuno Lopes</i></p> <p>.....</p>	79
<p>A PARAMETRIC STUDY ON THE APPLICABILITY OF THE 500°C ISOTHERM METHOD FOR INVESTIGATING INTERACTION CURVES OF COLUMNS EXPOSED TO FIRE <i>Lijie Wang, Robby Caspeelee and Luc Taerwe</i></p> <p>.....</p>	83
<p>FIRE RESISTANCE OF WOODEN CELLULAR SLABS WITH RECTANGULAR PERFORATIONS <i>Jorge Meireles, Elza Fonseca, Paulo Piloto and Débora Ferreira</i></p> <p>.....</p>	87
<p>NUMERICAL EVALUATION OF THE BEHAVIOR OF PARTIALLY ENCASED COMPOSITE BEAMS IN FIRE <i>Fabio M. Rocha and Jorge M. Neto</i></p> <p>.....</p>	91

ASSESSMENT OF THE SHEAR BEHAVIOUR OF T-SHAPED CONNECTORS AT ELEVATED TEMPERATURES <i>Luís Laím and João P.C. Rodrigues</i>	95
FIRE TESTS ON SLENDER CONCRETE FILLED TUBULAR COLUMNS SUBJECTED TO LARGE ECCENTRICITIES <i>Ana Espinós, Manuel L. Romero, Enrique Serra and Vicente Albero</i>	99
THERMO-STRUCTURAL ANALYSES OF RC BEAMS IN FIRE <i>Gabriela B.M.L. Albuquerque, Valdir Pignatta Silva and João Paulo C. Rodrigues</i>	103
PARAMETERS WITH INFLUENCE ON THE BEHAVIOR OF COMPOSITE TUBULAR COLUMNS SUBJECTED TO FIRE <i>Tiago A.C. Pires, João P.C. Rodrigues and José J.R. Silva</i>	107
FIRE BEHAVIOUR OF TABIQUE WALLS <i>Alexandre Araújo, Elza Fonseca, Débora Ferreira, Paulo Piloto and Jorge Pinto</i>	109
MECHANICAL RESPONSE OF TWO-LAYERED CURVED REINFORCED CONCRETE BEAM EXPOSED TO NATURAL FIRE CONDITIONS <i>Dušan Ružić, Miran Saje, Igor Planinc, Robert Pečenko and Tomaž Hozjan</i>	113
ASSESSMENT OF THE INFLUENCE OF THE VENTILATION IN ADVANCED FIRE MODELS <i>Iolanda Del Prete, Nicola Bianco, Emidio Nigro and Giuseppe Rotondo</i>	117
 MECHANICAL AND THERMAL PROPERTIES OF MATERIALS	
STRESS REDISTRIBUTION ALONG POST-INSTALLED REBARS UNDER NON-UNIFORM TEMPERATURE LOADING <i>Nicolas Pinoteau, Sébastien Rémond, Pierre Pimienta and Thierry Guillet</i>	123

<p>COMPRESSIVE STRENGTH OF FIBRE CONCRETES WITH ENHANCED FIRE BEHAVIOR <i>Hugo Caetano, João P.C. Rodrigues and Armando M. Junior</i></p> <p>.....</p>	125
<p>DETERMINATION OF WOOD THERMAL CONDUCTIVITY <i>Eduardo Schneid, Carolina da Rosa and Poliana D. Moraes</i></p> <p>.....</p>	127
<p>ULTRASONOGRAPHY APPLIED TO DETERMINE THE CONCRETE RESISTANCE UNDER A FIRE CONDITION <i>Armando L.M. Junior, Nádia S. Veiga, Carolina A.N. Alvim, André A. Garcia, Maria C.D. Relvas and Rafaela Montefusco</i></p> <p>.....</p>	131
<p>FIRE BEHAVIOUR OF LIGHTWEIGHT CONCRETE UNITS BASED ON CORN COB AGGREGATE <i>Nuno Alves, Paulo Piloto, Elza Fonseca, Luísa Barreira, Débora Ferreira and Jorge Pinto</i></p> <p>.....</p>	133
<p>THE RELATIONS BETWEEN THE ASSESSED DIAGNOSTIC PARAMETERS AND MECHANICAL PROPERTIES OF HEATED CONCRETES <i>Izabela Hager and Tomasz Tracz</i></p> <p>.....</p>	135
<p>COMPRESSIVE BEHAVIOUR OF A TIRE RECYCLED STEEL AND TEXTILE FIBER CONCRETE SUBJECTED TO FIRE <i>Cristina C. Santos and João P. Rodrigues</i></p> <p>.....</p>	137
<p>EXPERIMENTAL RESEARCH ON THE RESIDUAL MECHANICAL PROPERTIES OF AN ORDINARY CONCRETES AFTER FIRE <i>Cristina C. Santos and João P. Rodrigues</i></p> <p>.....</p>	141
<p>EXPERIMENTAL ANALYSIS ON THE COMPRESSIVE STRENGTH AT HIGH TEMPERATURES OF A CONCRETE WITH PET CHIPS <i>Hugo Caetano, João P. Rodrigues and Pierre Pimienta</i></p> <p>.....</p>	145

FIRE CHEMISTRY, PHYSICS AND COMBUSTION

A DESIGN FIRE MODEL FOR THE FULL PROCESS OF FIRE

Xia Zhang, Xiao Li and George Hadjisophocleous

.....149

TOXIC GAS ANALYSIS FROM COMPARTMENT FIRES USING HEATED RAW GAS SAMPLING WITH HEATED FTIR 50+ SPECIES GAS ANALYSIS

Abdulaziz A. Alarifi, Herodotos N. Phylaktou and Gordon E. Andrews

.....153

NUMERICAL SIMULATION OF VAPOUR CLOUD FIRES USING FLACS-FIRE

Deiveegan Muthusamy and Kees van Wingerden

.....157

IMPACT OF WOOD FIRE LOAD ON TOXIC EMISSIONS IN VENTILATION CONTROLLED COMPARTMENT FIRES

Bintu G. Mustafa, Gordon E. Andrews, Herodotos N. Phylaktou, Ayesha AlShammri, Vishal Shah and Omar A.O. Aljumaiah

.....159

THE EFFECT OF USING LIDS IN DIFFERENTIAL SCANNING CALORIMETER EXPERIMENTS FOR DETERMINING THE HEAT OF REACTION OF WOOD

Xiaoyun Wang, Charles Fleishmann and Michael Spearpoint

.....161

INVERSE MODEL FOR DETERMINING HEAT RELEASE RATES

Qianru Guo, Alvaro Salinas and Ann E. Jeffers

.....165

TOXIC GASES FROM COMPARTMENT FIRES WITH HANGING COTTON TOWELS AND LOW VENTILATION

Gordon E. Andrews, Paul Yeomans and Herodotos N. Phylaktou and Omar A. Aljumaiah

.....169

ANALYSIS OF A NEW PLATE THERMOMETER - THE COPPER DISC PLATE THERMOMETER

Alexandra Byström, Oskar Lind, Erika Palmklint, Petter Jönsson and Ulf Wickström

.....171

FIRE REACTION

NUMERICAL INVESTIGATION ON THE EFFECT OF SIDEWALLS AND OPENING GEOMETRY ON WINDOW EJECTED FACADE FLAMES

M. Duny, D. Dhima, J.P. Garo, H.Y. Wang and B. Martinez-Ramirez

.....177

BURNING OF POLYURETHANE FOAM CLOSE TO A WALL AND A CORNER DEPENDING ON SEPARATION DISTANCE

Junghoon Ji, Kazunori Harada, Yoshifumi Ohmiya, Masaki Noaki and Yichul Shin

.....181

THE APPLICATION OF DIFFERENT COMPONENT SCHEMES TO PREDICT WOOD PYROLYSIS AND FIRE BEHAVIOUR

Xiaoyun Wang, Charles Fleishmann and Michael Spearpoint

.....185

BURNING OF POLYURETHANE FOAM BLOCK IN ISO ROOM COMPARTMENT

Kazunori Harada, Ken Matsuyama, Kazuhiko Ido, Masaaki Noaki, Sungchan Lee and Jaeyoung Lee

.....189

NUMERICAL MODELING OF A VERTICAL WALL FIRE

M. Duny, D. Dhima, J.P. Garo, H.Y. Wang, and B. Martinez-Ramirez

.....193

FIRE SPREAD RESULTED FROM BURNING A DOUBLE-SKIN FAÇADE DEMONSTRATION RIG

Nadia C.L. Chow

.....195

TESTS ON INTUMESCENT PAINTS FOR FIRE PROTECTION OF EXISTING STEEL STRUCTURES

Antonio Bilotta, Donatella de Silva, Emidio Nigro and Luca Ponticelli

.....199

SMOKE CONTROL

ROAD TUNNEL - FIRE AND EVACUATION SCENARIO CASE STUDY <i>Dirceu Santos, João P. Rodrigues and Jorge Saraiva</i>	205
SCALE MODEL EXPERIMENTS ON SMOKE MOVEMENT IN A TILTED TUNNEL <i>S.I. Tsang, W.K. Chow and Gigi C.H. Lui</i>	207
FULL-SCALE TESTS AND CFD MODELLING TO INVESTIGATE THE EFFECT OF DIFFERENT MAKE-UP AIR VELOCITIES ON SMOKE LAYER HEIGHT IN ATRIUM FIRES <i>Amir Rafinazari and George Hadjisophocleous</i>	211
FULL-SIZE EXPERIMENTS OF AIR CURTAINS FOR SMOKE CONTROL IN CASE OF FIRE <i>João Carlos Viegas and Hildebrando Cruz</i>	213

FIRE RISK ASSESSMENT

THE EFFECTS OF CONSTRUCTION TYPE AND ACTIVE FIRE PROTECTION OPTION ON THE OVERALL BUILDING FIRE RISK <i>Xiao Li, Xia Zhang and George Hadjisophocleous</i>	219
SENSITIVITY ANALYSIS OF SIMULATION PARAMETERS FOR FIRE RISK ASSESSMENT <i>Damien Lamalle, Pierre Carlotti, Richard Perkins and Pietro Salizzoni</i>	223
FIRE RISK OF HORIZONTAL WOODEN STRUCTURES FULL SCALE VERIFICATION <i>Petr Hejtmánek, Luciano M. Bezerra and George C. B. Braga</i>	227
FIRE RISK ASSESSMENT OF INDUSTRIAL BUILDINGS – PARAMETERS THAT MAY HAVE INFLUENCE <i>Cecília Barra, João P. Rodrigues and Robert Fitzgerald</i>	231

EVACUATION AND FIREFIGHTING

THE EFFECTIVENESS OF FIRE EXITS IN COMPLEX BUILDINGS – A WAYFINDING EXPERIMENT

Rosaria Ono, Katia B.R. Moreira, Tomaz P. Leivas and Gilberto L. Camanho
.....235

METHODOLOGY TO VALIDATE THE 'FASTER IS SLOWER' CONCEPT

César Martín-Gómez, Iker Zuriguel, Natalia Mambrilla, Ángel Garcimartín and Martín Pastor
.....237

PARAMETERS FOR BREATHING PROTECTION EQUIPMENT CONSUMPTION: CONTRIBUTION FROM AN EXPERIMENTAL PROTOCOL.

Cristiano Corrêa, Anderson S. Castro, Aline Falcão, George C. Braga, José J.R. Silva and Tiago A.C. Pires
.....241

MULTICRITERIA EVALUATION OF EFFICIENCY IN THE URBAN FIREFIGHTING

José P. Lopes, Carlos H. Antunes and João P. Rodrigues
.....245

FIRE REGULATIONS, STANDARDIZATION AND CONSTRUCTION TRENDS

A FRAMEWORK FOR SYSTEMATIC DEVELOPMENT OF FIRE SCENARIOS AND QUANTIFIED DESIGN BASIS FIRES

Ian Jutras, Brian Meacham and Beth Tubbs
.....251

EXPERIMENTAL PLAN FOR ASSESSING FIRE PERFORMANCE OF SELECT 'GREEN' BUILDING FEATURES AND TECHNOLOGIES

Drew Martin, Brian Meacham and Nicholas Dembsey
.....255

RELIABILITY-BASED EQUIVALENT FIRE DURATION FOR CONCRETE ELEMENTS EXPOSED TO NATURAL FIRES

Ruben Van Coile, Robby Caspeele and Luc Taerwe
.....259

IMPORTANCE OF ACCOUNTABILITY IN BUILDING CONTROL: A CASE STUDY. <i>Amaya Osácar and Juan Echeverria</i>	261
RELIABILITY CENTERED MAINTENANCE APPROACH TO INSPECTION, TESTING, AND MAINTENANCE OF FIRE PROTECTION SYSTEMS AND EQUIPMENT <i>Lonny Simonian</i>	265
COMMENTS TO EUROPEAN CODE PROVISIONS FOR CONCRETE MODULUS OF ELASTICITY AT ELEVATED TEMPERATURES <i>Izabela Hager and Katarzyna Krzemień</i>	267



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FIRE BEHAVIOUR OF TABIQUE WALLS

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Keywords: Fire, Tabique, Traditional building techniques

1. INTRODUCTION

The tabique is one of the main Portuguese traditional building techniques, which is based on raw materials as earth and wood. In general, a tabique wall is formed by a simple timber structure covered by an earth-based material. Earth has an important role in this system because it protects the internal timber structure along with its finishing function. The northeast region of Portugal is very rich in terms of tabique construction heritage. Nowadays, the existing tabique constructions show a generalized and advanced stage of deterioration [1, 2, 3]. This aspect, associated to the fact that there is still a lack of scientific studies in this field, motivated this research work which main goals are to study, both experimental and numerical, the behaviour of this solution in terms of fire resistance using different earth-based material thicknesses. Also, it is intended to motivate and to give guidance for future rehabilitation works in this field. In relation to the earth-based mortar, and based on previous studies [4], it was shown that it is a material with adequate fire resistance. When exposed to fire action the wood inside tabique shows a decomposition process (pyrolysis) and produces a surrounding charring depth layer. On the fire exposure side a charcoal layer, without effective resistance, causes the reduction of the element cross-section. However, this charring depth layer can delay the heating process, from the exposed side, acting as an excellent insulating material. When compared to

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steel or concrete structures, wooden structures have therefore an improved structural behaviour [5].

2. MATERIAL AND METHODS

The thermal behaviour of tabique walls exposed to the fire action was evaluated using thermocouples for measuring internal and external temperatures of the wall. The entire procedure is based on EN 1364-1 [6]. The aim of this study is to investigate the behaviour of the earth-based mortar layer that protects the timber structure which constitutes the wall. Hence, thermocouples have been placed at different depths in order to obtain temperature records inside the mortar (TA) and in the wood (TM). The unexposed surface was instrumented also with disks thermocouples (TD), all arranged according to Figure 1.

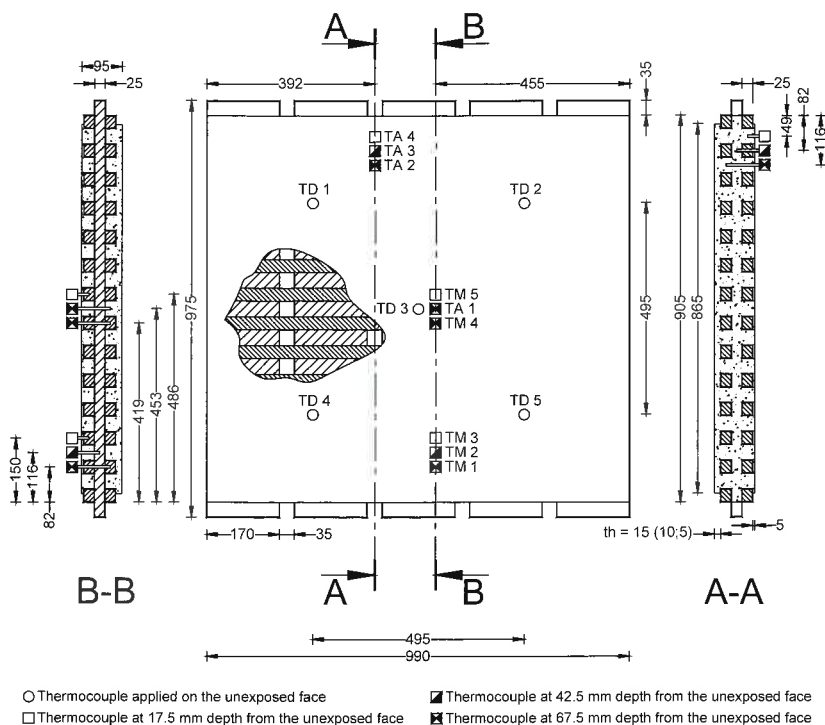


Figure 1: Panels geometry and thermocouples location (dimensions in mm)

The experimental tabique wall model has the appropriate geometry to be tested in a fire resistance furnace, prepared to follow ISO 834 standard fire curve. The tabique wall, at the

beginning of the test, was at ambient laboratory temperature of about 21°C. During the test, the integrity of the wall shall be evaluated throughout the test by cotton wool pads, gap gauges and monitoring the test specimen for evidence of sustained flaming, however there was only a significant amount of smoke release from burning wood at final stage of the test. In order to evaluate the earth-based mortar thickness effect, three walls were tested with different mortar layer thicknesses of 1.5 cm, 1.0 cm and 0.5 cm (see Figure 2).

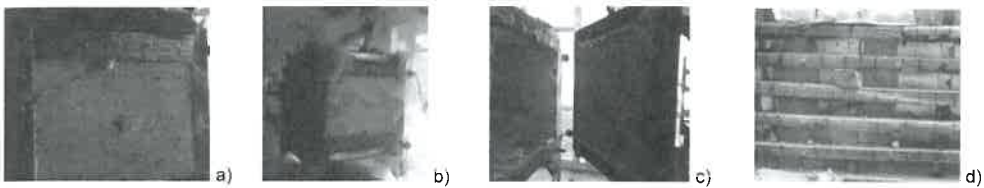


Figure 2: Tabique wall test: a) airtightness; b) smoke release; c) oven door; d) final aspect of tabique wall

Also, a tabique wall is investigated by theoretical approach with finite element method in order to predict its behaviour and its performance under fire exposure. For this purpose a 2D numerical simulation (side AA and side BB) is conducted with particular attention to the thermal properties of the wood and mortar materials within temperature. At the exposed wall face the fluid temperature follows the ISO 834 curve with a convection value equal to 25 W/m²K. At the unexposed face the ambient temperature is constant (26°C) and the value of convection equal to 4 W/m²K. The surface emissivity is taken 0.9 for both exposed and unexposed sides, [7]. Figure 3 shows the temperature evolution at the end of fire exposure (2100 s), for each 2D side. Both results represent the charring layer on the wood material, in grey colour.

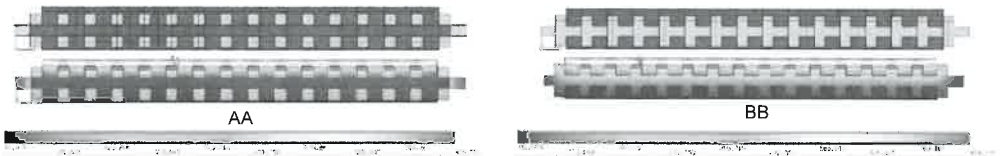


Figure 3: Numerical tabique wall results of the temperature.

3. RESULTS

Figures 3 and 4 show the experimental (T_e) and numerical (T_n) results obtained in tabique wall, with a 1.5 cm mortar thickness, after fire exposure, both for thermocouples located on wood structure (TM) and earth-based mortar (TA) respectively. In Figure 3, it can be seen that the thermocouples 1 and 4 (which are placed on wood at 6.75 cm depth) recorded the highest temperatures of approximately 100°C. Regarding the thermocouples located near the unexposed sur face, 1.75 cm deep, the temperature remained practically unchanged. Regarding earth-based mortar, the higher temperatures of about 180°C were recorded near to

the fire exposed side. The lowest temperature (about 80°C) was registered at 1.5 cm depth in the mortar. Regarding the results the obtained numerical results are in good concordance with experimental thermal response. Therefore, It can be concluded that the earth-based mortar acted as a fire exposure protecting layer to the wood structure improving the overall fire of this building element.

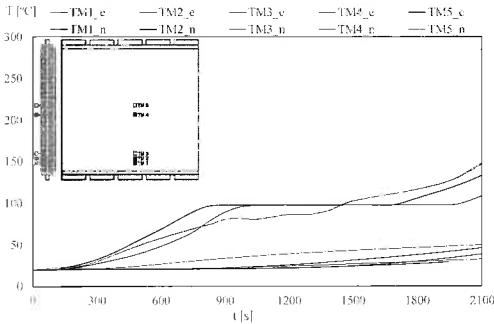


Figure 3 – Temperatures on wood

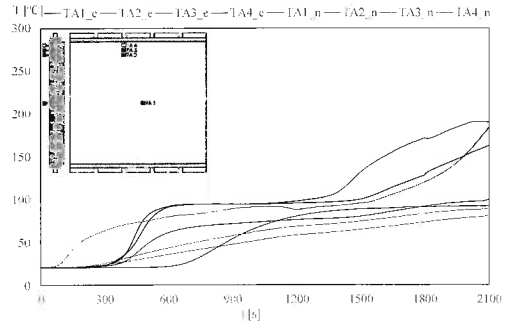


Figure 4 - Temperatures on earth-based material

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