1- INTRODUCTION

- The use of hybrid materials could increase the structural integrity of the construction elements.
- Steel material has many advantages over wood elements, strength, stability, resistance to woodworm, among others.
- Steel is incombustible and most of the times it can full recover strength after fire but, steel material conducts heat extremely well.
- Wood is a renewable resource, recently attracted by public attention.
- Wood is a natural material with good structural characteristics.
- The wood when exposed to accidental actions, such as fire conditions, has a surrounding charring depth.
- However, this layer can delay the heating process to the core section, acting as an insulating.

2- APPLICATIONS

Wood-steel applications.

3- OBJECTIVE AND WHY WOOD-STEEL MATERIAL?

- The main objective of this work is to provide the thermal analysis in wood-steel hybrid elements for building constructions under fire conditions.
- The use of wood-steel hybrid models has major advantages as increased fire resistance, improved high strength, leads to economic and ecologic benefits.
- The numerical modelling of these hybrid models, providing the analysis at high temperatures, is complicated due to the heat produced, to form a layer of carbonization surrounding the wood, and also the properties of both materials are nonlinear.
- The complexity of this analysis needs some numerical techniques with high performance, which is the case of the finite element analysis.
- Hybrid wood/steel material is used for new building projects, bridges, slabs, etc.

4- MATERIAL PROPERTIES

Wood and steel thermal properties.

5- WOOD-STEEL HYBRID PROFILE AND FIRE SCENARIO

When wood material is externally applied to the steel profile, plays an important role as insulation, reducing the temperature inside steel.
- Wood has a good fire resistance even for three sides exposure, showing the ability to protect the steel.

6- CONCLUSIONS

- Unprotected steel elements under fire condition may suffer serious damage.
- The use of hybrid wood/steel elements could increase both structural strength and stiffness.
- Wood could be considered as an insulating material, the core section could remain at low temperature, function of fire exposure time and element cross section size.

REFERENCES

# IRF2013 PROGRAM

## SUNDAY, 23 JUNE 2013

**SUN, 14:00 - 18:30**

**EARLY-BIRD REGISTRATION**

Lounge

**Early-Bird Registration**

and

**Welcome Drink**

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## MONDAY, 24 JUNE 2013

**MON, 09:00 - 09:30**

**OPENING SESSION**

Main A.

- **Welcome to Participants**
  (Conference Co-Chairs)

- **Welcome Address**
  (President of Regional Government / Dean of FEUP / Dean of U. Madeira)

**MON, 09:30 - 10:15**

**PLENARY LECTURE I**

Main A.

- **DYNAMIC CONTACT IN CONTINUA USING VARIATIONAL INEQUALITIES**
  Professor Shaker A. Meguid
  (University of Toronto, Canada)
  Chair: Professor J.F. Silva Gomes (FEUP, Portugal)

**MON, 10:15 - 11:00**

**PLENARY LECTURE II**

Main A.

- **RECENT DEVELOPMENTS ON MPM AND ITS APPLICATION IN IMPACT AND EXPLOSION SIMULATION**
  Professor Xiong Zhang
  (Tsinghua University, P. R. China)
  Chair: Professor Mário A.P. Vaz (FEUP, Portugal)

**MON, 11:00 - 11:30**

**COFFEE-BREAK**

Lounge
Monday, 24 June 2013

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Chair: Xiong Zhang (Tsinghua University, China)

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**Chair:** João Tavares (FEUP, Portugal)

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**Chairs:** João Baptista (FEUP, Portugal), Miguel Tato Diogo (FEUP, Portugal)

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**Chair:** Anabela Alves (U. Minho, Portugal)

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**Chair:** Luisa Madureira (U. Porto, Portugal)

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**Chair:** Peter Hess (U. Heidelberg, Germany)

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**Chair:** Valeriy Lepov (IPTPN SB RAS, Russia)

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**Topic_D: CIVIL ENGINEERING APPLICATIONS**
**Chair:** Lino Maia (U. Madeira, Portugal)

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Chairs: Hernani Lopes (IPB, Portugal), João Ribeiro (IPB, Portugal)

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DESIGN FOR RELIABILITY AND MAINTAINABILITY
Professor E.A. Elsayed
(Rutgers University, USA)
Chair: Professor Sergei T. Mileiko (Russian Academy of Sciences, Russia)

TUE, 10:15 - 11:00 PLENARY LECTURE IV A-101

ULTRA LOW FRICTION OF AMORPHOUS CARBON NITRIDE WITH CONTROLLING NANO SURFACE STRUCTURE
Professor Noritsugu Umehara
(Nagoya University, Japan)
Chair: Professor Shaker A. Meguid (University of Toronto, Canada)

TUE, 11:00 - 11:30 COFFEE-BREAK Lounge

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**SESSION 4F**  
**Room F**  

| Symp_28 | FIRE AND STRUCTURAL ENGINEERING  
Chairs: | Paulo Piloto (IPB, Portugal), Alberto Meda (U. Rome, Italy)  
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**TUE, 11:30-13:00 SESSION 4G Room G**

**Topic_M:** IMPACT AND CRASHWORTHINESS  
**Chair:** José Cirne (U. Coimbra, Portugal)

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**TUE, 13:00 - 14:00 LUNCH REST**

**TUE, 14:00-15:30 SESSION 5A Room A**

**Topic_H:** MODES OF FAILURE  
**Chair:** Paraskevas Papanikos (U. Aegean, Greece)

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**Topic_J:** NANOTECHNOLOGIES AND NANOMATERIALS  
**Chair:** Shaker A. Meguid (U. Toronto, Canada)

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**SESSION 5D**
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**Symp_14:** ASSESSMENT, MONITORING AND CONTROL OF CIVIL ENGINEERING STRUCTURES
**Chairs:** Elsa Caetano (FEUP, Portugal), Álvaro Cunha (FEUP, Portugal)
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| 4047 | SEISMIC VULNERABILITY OF STRATEGIC BUILDINGS IN ORAN (ALGERIA). Ramdane Kheir-Eddine, Senouci Abbas, Mammar Lahouari. | 591 |
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**TUE, 14:00-15:30**
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**Room F**
**Symp_10:** STRUCTURAL AND MULTIDISCIPLINARY OPTIMIZATION
**Chair:** Carlos C. António (FEUP, Portugal)
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**Symp_12: VIBRATION AND STRUCTURAL ACOUSTICS ANALYSIS**

**Chair:** César Vasques (INEGI, Portugal)

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### TUE, 15:30 - 16:00 COFFEE-BREAK Lounge

### TUE, 16:00-17:30 SESSION 6A Room A

**Topic_H: MODES OF FAILURE**

**Chair:** Volodymyr Hutsaylyuk (Military University of Technology, Poland)

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### TUE, 16:00-17:30 SESSION 6B Room B

**Symp_5: BLOOD FLOW MECHANICAL BEHAVIOUR**

**Chairs:** Catarina Castro (U. Porto, Portugal), Luisa Sousa (U. Porto, Portugal)

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### SESSION 6C  
**Room C**

**Topic:** COMPOSITE MATERIALS  
**Chair:** Andrey Nasedkin (Southern Federal University, Russia)

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**Room D**

**Symp_15:** BEHAVIOUR CHARACTERIZATION OF CONSTRUCTIONS FOR EARTHQUAKE DEMANDS  
**Chairs:** Humberto Varum (A. Aveiro, Portugal), Hugo Rodrigues (U. Aveiro, Portugal)

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**Symp_6:** INTEGRITY, RELIABILITY AND FAILURE IN DENTAL MATERIALS AND APPLIANCES  
**Chairs:** André Correia (FMDUP, Portugal), J.C. Reis Campos (FMDUP, Portugal)

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**Symp_10:** STRUCTURAL AND MULTIDISCIPLINARY OPTIMIZATION  
**Chair:** Carlos C. António (FEUP, Portugal)

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4751 DECONVOLUTION ALGORITHMS AND THEIR APPLICATIONS IN ULTRASONIC INSPECTION OF CFRP MATERIAL. Abdessalem Benammar, Redouane Drai.

3949 ASSESSMENT OF A FULL SCALE PEDESTRIAN BRIDGE BY MODEL UPDATING. Faisal Shabbir, Piotr Omenzetter.


4689 A NONLINEAR SOIL CONSTITUTIVE MODEL BASED ON HYPERBOLIC TANGENT FUNCTION. YuQin Ding, YongXing Zhang.

TUE, 19:00 - 23:00 BANQUET
Casino

CONFERENCE BANQUET
Casino do Funchal
(FUNCHAL)

WEDNESDAY, 26 JUNE 2013

WED, 08:30 - 09:30 POSTER SESSION IV Lounge

Symposia: 16 to 32

REF: Title and Author(s):

4731 DESIGN OF COLOURED SELF-COMPACTING CONCRETE MADE WITH CRUSHED VULCANIC AGGREGATES. Lino Maia, Celestino Gomes, Miguel Guimarães.

4771 MODULUS OF ELASTICITY OF CONCRETE PRODUCED WITH BASALTIC AGGREGATES. Lino Maia, Cátia Caetano, Miguel Correia, José Santos.

4651 MODEL FIRE OF TWO STOREY WOODEN FRAME BUILDING. Linda Makovická Osvaldová, Anton Osvald, Martin Petho.

4102 A CONTRIBUTION TO ASSESS THE STRUCTURAL VULNERABILITY OF TRADITIONAL TIMBER PAVEMENTS. Marcos Teixeira, Débora Ferreira, Vítor Cunha, Artur Feio, José Lousada, Humberto Varum, João M. Guedes, Jorge Pinto.


4646 PROPOSAL OF A PATH TO SELECT A MATRICIAL METHOD FOR RISK ASSESSMENT. Cátia Ferreira, J. Santos Baptista.

4656 DEVELOPMENT AND MECHANICAL CHARACTERIZATION OF BIO-COMPOSITES FOR APPLICATION IN LIGHT-WEIGHT CONSTRUCTION. A. Alves, J. Velosa, S. Patinha, S. Rana, R. Fangueiro.

3924 A DSP SYSTEM APPLIED TO ELECTROMECHANICAL IMPEDANCE-BASED SHM ARCHITECTURE. Carlos A. Gallo, Antonio C. Oliveira Jr, Roberto M.F. Neto.

4376 PRACTICAL DETERMINATION OF A RELIABILITY TEST SCOPE. Zdenek Vintr.

4763 DIMENSIONAL CONTROL CASE STUDY IN A PUNCHING CELL. J.M. Herrera Olivenza, D. Rodríguez Salgago, I. Cambero Rivero, J. García Sanz-Calcedo.

4700 INFLUENCE OF AGEING OVER NON ACTIVE MEDICAL DEVICES. Maria José Abreu.

4054 ULTRASONIC PEENING IN INDUSTRIAL APPLICATIONS. Jacob Kleiman.

3967 ANALYTICAL AND NUMERICAL ASSESSMENT OF FATIGUE PROPERTIES IN ROLLING BEARINGS. Paweł Romanowicz, Bogdan Szybiński.

4743 INFLUENCE OF COMPOSITE PATCH REPAIR ON FATIGUE CRACK GROWTH OF 6061 AL-ALLOY. Mustapha Benachour, Nadjia Benachour, Mohamed Benguediba.
### WED, 09:30-11:00  SESSION 7A  Room A

**Symp_32: FAILURE AND FATIGUE OF STRUCTURAL ELEMENTS**  
**Chair:** Aleksander Muc (Cracow U.T., Poland)

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**Symp_31: MICROMECHANICS AND HOMOGENIZATION OF HETEROGENEOUS MEDIA**  
**Chairs:** Marek-Jerzy Pindera (U. Virginia, USA), Marcio A.A. Cavalcante (F. U. Alagoas, Brazil)

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**Symp_11: INNOVATIVE JOINING PROCESSES**  
**Chair:** Pedro Moreira (INEGI, Portugal)

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**Symp_13: DYNAMICS, STABILITY AND CONTROL IN ENGINEERING STRUCTURES**  
**Chair:** Rui C. Barros (U. Porto, Portugal)

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**Symp_07: MECHANICAL CHARACTERIZATION OF BONE BEHAVIOR**

**Chairs:** Marcelo Moura (U. Porto, Portugal), Nuno Dourado (UTAD, Portugal)

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**Topic_N:** CASE STUDIES

**Chair:** Jan Chvojan (VZU Plzen, Czech Rep)

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**Symp_27: STRUCTURAL HEALTH MONITORING OF ADVANCED STRUCTURES**

**Chairs:** Júlio C. Viana (Critical Materials, Portugal), Gustavo Dias (Critical Materials, Portugal)

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**Room G**

**Topic:** ENERGY AND THERMO-FLUIDS SYSTEMS

**Chairs:** Cito Afonso (U. Porto, Portugal)

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- 4007 IMPLEMENTATION OF A HYDRIC ENERGY HARVESTING SYSTEM FOR WIRELESS SENSOR NETWORKS. Filipe Santos, Joaquim Azevedo. 357
- 4049 THE EFFECT OF THERMAL BARRIER COATING ON THE LIFE EXTENSION OF A GAS TURBINE ROTARY BLADE. Reza Torabideh, Saeed A. Kouhanjani, Hamid M. Zoka, Maryam Torfeh, Reza Ghorbani. 363
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### WED, 11:00 - 11:30
#### COFFEE-BREAK
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### WED, 11:30-13:00
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**Room A**

**Symp_32:** FAILURE AND FATIGUE OF STRUCTURAL ELEMENTS

**Chair:** Aleksander Muc (Cracow U.T., Poland)

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**Room B**

**Symp_31:** MICROMECHANICS AND HOMOGENIZATION OF HETEROGENEOUS MEDIA

**Chairs:** Marcio A.A. Cavalcante (F.U. Alagoas, Brazil), Marek-Jerzy Pindera (U. Virginia, USA)

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- 4239 DISPERSION MONITORING ANALYSIS AND OPTIMISATION FOR EPOXY NANOREINFORCEMENT. Alkiviadis Paipetis, Giorgos Gikikas. 797
- 3933 HOMOGENIZATION OF MAGNETORHEOLOGICAL ELASTOMERS CONSIDERING GEOMETRICAL NONLINEARITIES. George Chatzigeorgiou, Ali Javili, Paul Steinmann. 799
- 3887 TARGETING THE RESPONSE OF BIOLOGICAL TISSUE VIA FINITE-VOLUME MICROMECHANICS. Wenqiong Tu, Marek-Jerzy Pindera. 801

### WED, 11:30-13:00
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**Room C**

**Symp_26:** ADVANCES IN FIBROUS AND COMPOSITE MATERIALS FOR CIVIL ENGINEERING

**Chairs:** Raúl Fangueiro (U. Minho, Portugal), Sohel Rana (U. Minho, Portugal)

**REF:** Title and Author(s): Page:

- 4747 NANO-REINFORCED CONCRETE: AN INTELLIGENT AND HIGH PERFORMANCE CONSTRUCTION MATERIAL. Sohel Rana, Shama Parveen, Raul Fangueiro. 711
- 4091 FLEXURAL BEHAVIOUR OF BRICK MASONRY RETROFITTED WITH BRAIDED TEXTILE MESHES. Graça Vasconcelos, Juan Mora, Raul Fangueiro, Fernando Cunha, Andreia Martins. 713
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**Session 8D**

**Wednesday, 11:30-13:00**

**Symp_17: CONCRETE MATERIAL PERFORMANCE**

**Chairs:** Nuno Dourado (UTAD, Portugal), Marcelo Moura (U. Porto, Portugal)

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**Session 8E**

**Wednesday, 11:30-13:00**

**Symp_30: MEDICAL DEVICES AND HEALTHCARE MATERIALS**

**Chairs:** Maria José Abreu (U. Minho, Portugal), André Catarino (U. Minho, Portugal)

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**Session 8F**

**Wednesday, 11:30-13:00**

**Topic_N: CASE STUDIES**

**Chair:** Jorge Lino (U. Porto, Portugal)

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<td>Pedro V. Gamboa, Pedro D.R. Santos, José M.A. Silva, Pedro M.B. Santos.</td>
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**SESSION 8G**  
**Room G**

**Symp_1:** SMART STRUCTURES AND MATERIALS  
**Chair:** Maria José Geraldes  
(UBI, Portugal)

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**Symp_20:** THERMODYNAMICS AND THERMO-FLUID SYSTEMS  
**Chairs:** Clito F. Afonso  
(FEUP, Portugal) and Carlos C. António  
(FEUP, Portugal)

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### WED, 13:00 - 13:30  
**CLOSING SESSION**  
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**CLOSING SESSION**  
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**LUNCH**  
**REST**

**LUNCH**  
AND  
**END OF CONFERENCE**
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