



Basis of Structural Timber Design  
from Research to Standards

 **cost**  
FP1402

2<sup>nd</sup> Training School

Final Programme

Final Programme

**2<sup>nd</sup> Training School COST Action FP1402**

**“Design of timber-concrete-composite systems”**

University of Coimbra, Portugal  
Monday 9<sup>th</sup> – Friday 13<sup>th</sup> April 2018

**Local Organizer**

**Alfredo Dias**

Assistant Professor, Dr. sc.  
Department of Civil Engineering

**University of Coimbra**

Polo II  
Rua Luís Reis Santos  
3030-788 Coimbra  
EU – Portugal  
[www.uc.pt](http://www.uc.pt)



UNIVERSIDADE DE COIMBRA

**Co-Organizer**

**Jörg Schänzlin**

Professor, Dr.-Ing. habil, PD  
Department of Civil Engineering

**HBC. Hochschule Biberach,  
University of Applied Science  
Department of Civil engineering  
Institute for Timber design**  
Karlstr. 11, 88740 Biberach  
EU - Germany  
[www.hochschule-BC.de](http://www.hochschule-BC.de)

**HBC. HOCHSCHULE BIBERACH**  
UNIVERSITY OF APPLIED SCIENCES





## SCOPE

In the recent years a lot of research and development on timber concrete composite structures has been conducted throughout Europe. The range of this research covers the determination of the properties of the connectors, the determination of the internal stresses for the short term as well as for the long term situation as well as the discussion about the input values necessary for the design. At the same time, timber-concrete-composite systems have been realized in practice, so the academic knowledge has already been transferred to real buildings.

However the knowledge and the experience in the application are unevenly spread over Europe. To mitigate this, this distributed knowledge was collected and summarized in the recent years. One output of this collection is the development of a Technical Specification, which will eventually become part of an upcoming new version of the European design standards, the Eurocodes.

## CONTENT

In the training school relevant aspects of the design of TCC will be presented. The scientific background of the design approaches will be shown.

This covers

- General aspects of the design of TCC, e.g. built examples, advantages and disadvantages of TCC
- Connections between timber and concrete e.g. collection of possible connectors, mechanical properties of the connectors
- Short term behavior of systems subjected to bending e.g. determination of the internal forces with respect to the deformability of the connectors, effect, effect of cracking of concrete and behavior in the hogging zone,
- Long term behavior of TCC e.g. consideration of inelastic strains as shrinkage, consideration of creep deformations, stress redistribution
- Design approaches
- Necessary input values for the design, e.g. partial factors, temperature and moisture variations
- Background to the tests performed as e.g. recommended test setup, load histories

As an output of this training school the participants will get contact with the design procedures, the background and the reasons of all the differences between the common design of pure timber structures and the design of timber-concrete-composite systems. So the participants will be prepared for the point in time, when the Technical Specification developed within CEN/TC250/PT5.2 will be basis of an upcoming standard for the design of TCC.





## LIST OF TRAINERS



**Alfredo Dias, University of Coimbra**

Alfredo Dias is Professor at Civil Engineering Department from the University of Coimbra. He received his graduation in 1997 in Civil Engineering from University of Coimbra. In 2005 he received his PhD degree in Civil Engineering from the University of Delft in The Netherlands. For more than 15 years he has been deeply involved with research and consultancy in the field of Timber-Concrete composite solutions. Within COST Action FP1402 Alfredo is Co-Chair of the WG4 – Hybrid Structures. From 2009 he has been involved with the work of TC250\SC5 – Eurocode 5 being at the moment convenor of the WG2 – Composite Timber Structures. At the moment he is also involved in the development of the new versions of the Eurocodes being the convenor from the Project Team SC5.T2 – New part for Eurocode 5.



**Massimo Fragiaccomo, University of Aquila**

Massimo Fragiaccomo is Professor of Structural Engineering in the Department of Civil, Construction-Architectural & Environmental Engineering of University of L'Aquila, Italy since September 2015. Previous positions held include eight years as an Associate Professor at the University of Sassari, Italy, and three years as Senior Lecturer at the University of Canterbury, New Zealand. He is an author of 303 papers, 101 of which published on peer reviewed international journals. For his research activity he has





received several prizes including the Frederick Palmer Prize offered by the Institution of Civil Engineers – UK in 2012. He is member of the Working Groups CEN/TC250/SC5 “Eurocode 5: Design of Timber Structures” and CEN/TC250/SC8 “Eurocode 8: Design of structures for earthquake resistance” and the corresponding Italian mirror committees, as well as chairman of Working Group 3 “Timber Structures” within CEN/TC250/SC8.



**Frank Kupferle, C4Ci**

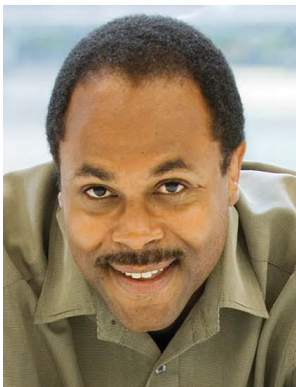
Frank Kupferle is Senior Consultant and Managing Director of C4Ci Sarl, an engineering consultancy office specialised in innovative product development and technical evaluation, also developing structural design software. He graduated in 1995 as an Ingénieur Civil des Mines at the École des Mines de Nancy. Within his 22 years of experience in the building industry, he has managed construction sites for 7 years, managed a set of 6 ready-mix concrete plants for 2 years. After 5 years as Technical Director for European division of Trus Joist Weyerhaeuser (market leading engineered wood products manufacturer) he has founded C4Ci and assessed or assisted in their assessment several construction products or systems amongst which proprietary Timber-Concrete composite systems. Since 5 years he regularly conducts projects for the French timber industry. He has recently been appointed Vice-President of the GS 3 expert committee for structural products within the CCFAT (French technical approval commission) hosted by the CSTB. He is involved as expert and member of the delegation in the development of new versions of Eurocode 5 (TC250/SC5/WG2 Timber concrete composites and TC250/SC5/WG3 – Subgroup Vibration) and in COST Action FP1402 within WG4 – Hybrid Structures.





**Luís Jorge, Polytechnic Institute of Castelo Branco, Portugal**

Luís Jorge is Professor at Civil Engineering Department from the Polytechnic Institute of Castelo Branco. He received his graduation in Civil Engineering in 1996 from University of Coimbra. In 2006 he received his PhD degree in Civil Engineering from the University of Coimbra. He belongs to the academic staff of the Master in Sustainable Construction on the Polytechnic Institute of Castelo Branco. He is manager of the company TISEM, Lda, partner of Austrian CLT producer KLH. Over the last 10 years he is focussed on CLT structures design and tendering. He is involved on WG2 of COST Action FP1402.



**Wendel Sebastian, University College London (UCL), UK**

Wendel Sebastian is Reader in Structural Engineering at the Department of Civil, Environmental and Geomatic Engineering (CEGE), University College London (UCL). He was previously an academic staff member at the University of Bristol, after completing MA and PhD studies at Cambridge University. He is editor-in-chief of the Structures and Buildings international journal, published by the Institution of Civil Engineers (UK). In 2012 he was awarded a Leverhulme Trust Senior Research Fellowship by the Royal Academy of Engineering, for research collaboration at EPFL (Switzerland). His research on composite structures of different construction materials, including timber-concrete composites (TCCs), is conducted via tests and finite element (FE) or algebraic nonlinear





analysis. He is co-director of the new UCL CECE labs for co-existent mechanical and environmental loading of large structures. Dr Sebastian's self-developed nonlinear FE code has been applied to a spectrum of composite structures, producing publications in key journals e.g. ASCE JSE, JCBM, IJSS. His research has underpinned design of TCC floors in a timber-framed building in London, scheduled for completion in 2019. He is a member of COST FP 1402 WG4 on timber hybrid structures.



### **Jörg Schänzlin, Hochschule Biberach**

In 1998 Jörg Schänzlin graduated as a “Diplom-Ingenieur” at the University of Stuttgart. From 1998 to 2009 he was scientific assistant at the Institute of Structural Design, Prof. Kuhlmann at the University of Stuttgart. In 2003 he received his PhD degree. In 2009 he received the Habilitation. Since 2009 he is “Privatdozent” in the field of timber design at the Faculty of Civil engineering at the University of Stuttgart. From 2009 to 2015 he was working full time at the Konstruktionsgruppe Bauen AG (KBK), a medium-size design office in Kempten, dealing mainly with the rehabilitation of timber, concrete and steel structures for buildings and bridges. Since 2012 he is a chartered engineer at the Bayerische Ingenieurekammer Bau. Since 2014 he is part-time manager of the R&D department at the KBK. Since 2015 he is professor at the University of Applied Science in Biberach and head of the institute of timber design.

Within COST Action FP1402 Jörg is Chair of WG4 – Hybrid Structures. From 2015 has been involved in the work of TC250\SC5 – Eurocode 5 being at the moment member of the Projectteam 5.2 – Composite Timber Structures.

### **TARGET GROUP**

The target group is students, PhD-students, and practical engineers, who will come in touch with TCC in the future on the field of research as well as practical application.

The envisaged number of attendees is 35 (subject to budget allocated to FP1402 for 2018). In case a selection of participants is necessary, COST rules on gender and country participation will be considered.





## PROGRAMME

Monday 09th – Friday 13th April 2018

Monday 09 <sup>th</sup>		
09:00 – 10:30	<b>General</b> <ul style="list-style-type: none"><li>• History of TCC</li><li>• General principles</li><li>• Range of application</li><li>• Systems</li><li>• Different habits/applications across various EU countries</li><li>• Built examples</li><li>• Advantages/disadvantages</li><li>• Key technical topics and issues</li><li>• Introducing the program</li></ul>	<b>Frank Kupferle</b>
11:00 – 12:30 and 14:00 – 15:30	<b>Connection</b> <ul style="list-style-type: none"><li>• Type of connectors</li><li>• Summary of the non-proprietary/proprietary systems</li><li>• Advantages/disadvantages of the connectors</li><li>• Recommended range of application</li><li>• Definition of important values as ultimate load/<math>K_{ser}/K_u</math></li><li>• Evaluation of these values</li><li>• Ductile/non ductile behavior</li><li>• Effect of an interlayer</li></ul>	<b>Alfredo Dias</b>





15:45 – 17:15	<b>Testing (Laboratory)</b> <ul style="list-style-type: none"><li>• Connection &amp; beams<ul style="list-style-type: none"><li>○ Standards</li><li>○ Test-setups</li><li>○ Advantages/disadvantages of the different test setups</li><li>○ Measured values</li></ul></li><li>• Example test of a notch and dowel type fastener</li></ul>	<b>Alfredo Dias</b>
<b>Tuesday 10<sup>th</sup></b>		
9:00 – 10:30 and 11:00 – 12:30	<b>Short term</b> <ul style="list-style-type: none"><li>• Design methods<ul style="list-style-type: none"><li>○ <math>\gamma</math>-method</li><li>○ Shear analogy method</li><li>○ Differential equation</li><li>○ Strut &amp; tie model</li></ul></li><li>• Important influences</li><li>• Effective width</li><li>• Linear/non-linear design</li><li>• Concrete cracking</li></ul>	<b>Wendel Sebastian</b>
14:00 – 15:30	<b>Long term (Part I)</b>	





	<ul style="list-style-type: none"><li>• General behavior of the components</li><li>• Creep in composite structures</li><li>• Creep vs. relaxation</li></ul>	
15:45 – 17:15	<b>Testing of a TCC beam with different connection systems, in order to determine the elastic stiffness (Laboratory)</b> <ul style="list-style-type: none"><li>• Different prestressing of the bolts</li><li>• Influence of friction</li></ul>	<b>Alfredo Dias</b>
<b>Wednesday 11<sup>th</sup></b>		
9:00 – 10:30 &	<b>Long term behavior</b> <ul style="list-style-type: none"><li>• Critical point in time</li><li>• Derivation of effective creep coefficients</li></ul>	<b>Jörg Schänzlin</b>
11:00 – 12:30	<b>Fire and Vibration</b> <ul style="list-style-type: none"><li>• Fire performance</li><li>• Fire analysis and design</li><li>• Vibration analysis</li><li>• Vibration design</li></ul>	<b>Frank Kupferle</b>
14:00 – 15:30	<b>Influence of the building process</b>	<b>Massimo Fragiaco</b>





Program

	<ul style="list-style-type: none"> <li>Prefabricated vs. cast-in-situ structures</li> <li>Full or partial prefabrication</li> <li>Propping of structures</li> <li>Consideration of the sequence of construction</li> </ul>	
15:45 – 17:15	<p><b>Input values</b></p> <ul style="list-style-type: none"> <li>Loads</li> <li>Temperature</li> <li>Shrinkage</li> <li>Annual variation/difference between time of erection and service</li> </ul> <p><b>Data analysis</b></p> <ul style="list-style-type: none"> <li>From test results to design values</li> <li>Analysis of a long duration test with 2-2.5 months monitoring</li> <li>Delivery of design data</li> </ul>	<p><b>Massimo Fragiacomò</b></p>     <p><b>Alfredo Dias</b></p>
<b>Thursday 12<sup>th</sup></b>		
9:00 – 10:30	<p><b>Design</b></p> <ul style="list-style-type: none"> <li>Verifications in the short and in the long-term at             <ul style="list-style-type: none"> <li>SLS</li> <li>ULS</li> </ul> </li> <li>Consideration of sequence of construction</li> </ul>	<b>Massimo Fragiacomò</b>





Training School

Program

	<ul style="list-style-type: none"><li>• Consideration of existing loads</li></ul>	
11:00 – 12:30	<b>Test until failure (Laboratory)</b>	<b>Alfredo Dias</b>
14:00 – 15:30	<b>Practical example of a design</b>	<b>Massimo Fragiaco</b>
15:45 -- 17:15	<b>Practical example of a design</b> <ul style="list-style-type: none"><li>• Built examples</li><li>• Boundaries</li><li>• Details</li></ul>	<b>Frank Kupferle</b>
<b>Friday 13<sup>th</sup></b>		
9:00 –10:30	<b>Design example of a bridge</b>	<b>Luis Jorge</b>
11:00 – 12:30	<b>Application example as summary of the training school</b>	<b>Participants</b>





## TRAVEL INFORMATION

The Training School will take place at the University of Coimbra in Coimbra, Portugal. The university was founded in 1537 and is the oldest university in Portugal. Currently the University of Coimbra has three poles of education where its eight faculties (literature, law, medicine, science and technology, pharmacy, economy, psychology and educational sciences, sport's science and physical education) are located. Nowadays more than 22 thousand academics study in the University of Coimbra. In 2013 the University of Coimbra was considered as a World Heritage site by UNESCO.

Coimbra is about 2.0 hours car drive away from Lisbon and about 1.5 hours car drive away from Porto. Travel by train is also possible:

Porto Airport - Coimbra

Metro from the airport to Train Station Campanhã (aprox. 40min)

Train from Porto Campanhã to Coimbra (aprox. 1h)

Lisbon Airport – Coimbra

Metro from the airport to Oriente Train Station (aprox. 15min)

Oriente Train Station to Coimbra (aprox. 1h45min)

The civil engineering department is located on the right bank of the river Mondego, which gives it a privileged location, as it is in an area with easy access to the most emblematic areas of the city where in the free time you can visit its cultural heritage and is also close of the Green Park of the Mondego that is located along the river Mondego where it is possible to enjoy the nature.



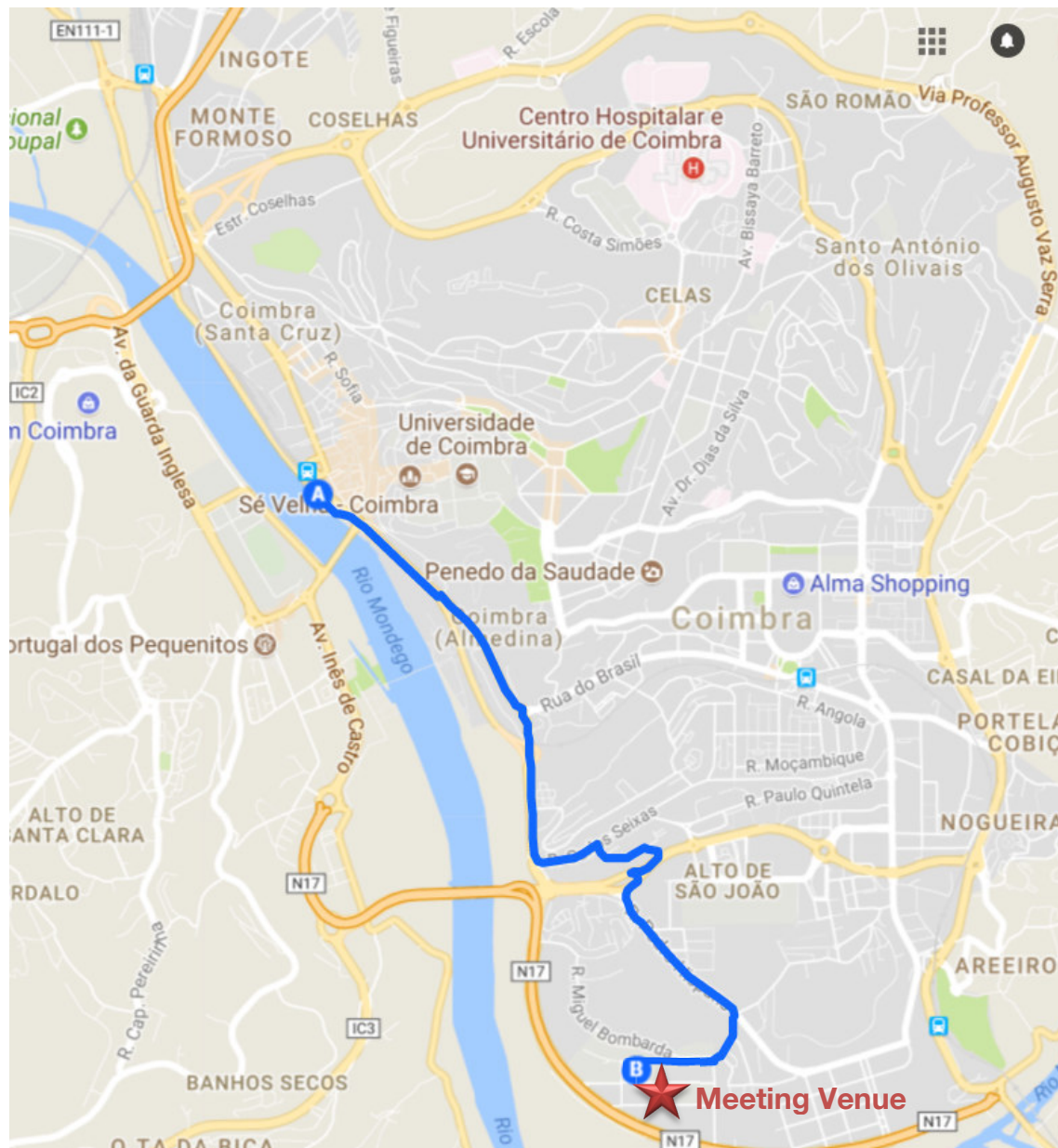




## VENUE INFORMATION

On Monday April 9<sup>th</sup>, , we will all meet at the Faculty of Science and Technology, University of Coimbra, in the Department of Civil Engineering is located at Pólo II, Rua Luís Reis Santos, 3030-788 Coimbra.

How to get to the Department of Civil Engineering from the train station Coimbra A:





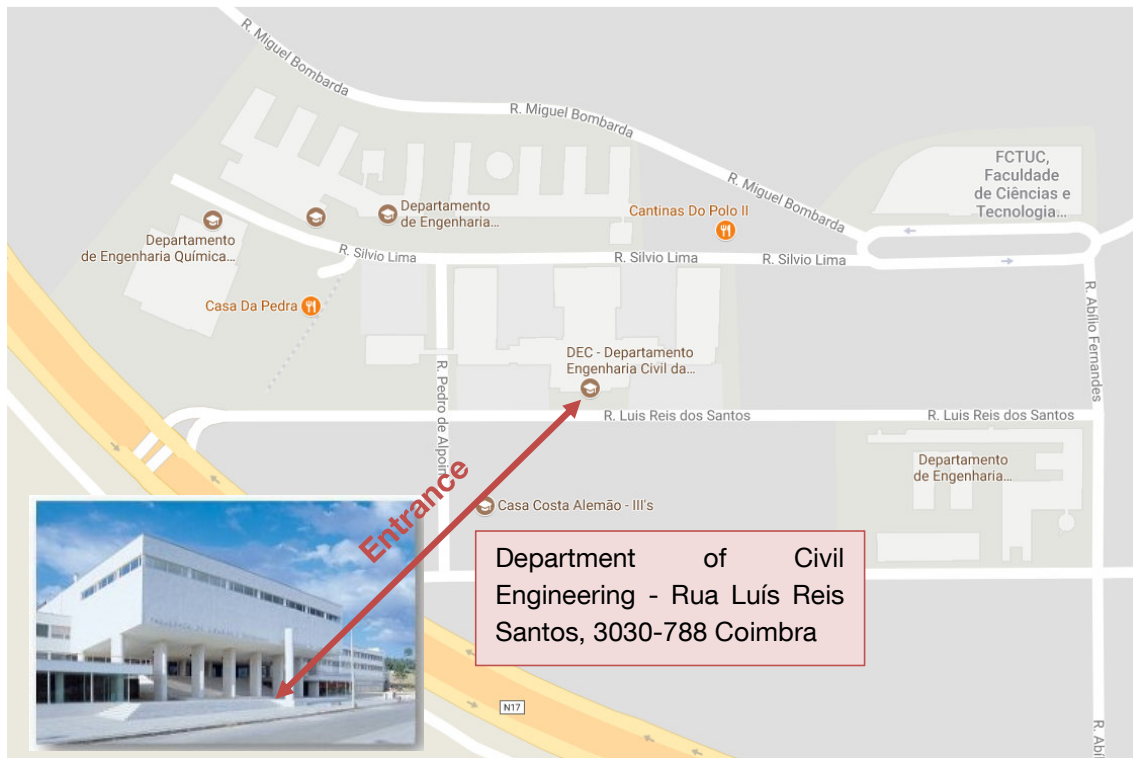


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## HOTEL INFORMATION

### Accommodation in Coimbra

The hotel accommodation in Coimbra from April 9-13 is under own arrangements. We recommend the below hotels in the city center.



<http://hotelbotanicocoimbra.pt/>



<https://www.hoteloslo-coimbra.pt/>





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<https://www.donaines.pt/>



<http://riversuites.pt/>



<http://hotel-tivoli-coimbra.h-rez.com/>

Other recommended budget accommodations:

- IBIS Hotel Coimbra (<http://www.ibis.com/pt/hotel-1672-ibis-coimbra-centro/index.shtml>)
- Serenata Hostel (<http://www.serenatahostel.com/home>)
- Sé Velha Hostel (<http://www.sevelhahostel.com/index>)

### Meals:

The lunches and refreshments in the morning and afternoon break will be provided by the organizers during the whole training school. A common dinner will also be organized on one of the days.

### Payment:

No payment is to be made to the organizers, the grants will be organized by Mao Ono (ono@tum.de)

### Disclaimer:

The budgetary contracts for the next grant period (01/05/17 – 30/04/18) of our COST Action have been signed by all parties involved. However we are required to inform you that in the very unlikely case that there is a shutdown of COST and its budgets (which has never happened before), the cancellation fees for the stay can neither be born by the Grant holder, nor by the local organizer but will have to be born by the whole group.