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IMFSE Master's dissertations in 2024 – A brief overview

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Introduction

Since the start of the International Master of Science in Fire Safety Engineering (IMFSE), there has been a wide variety of topics in the IMFSE master's dissertations [1]. In this article we aim to provide a brief overview of the 2024 edition, and more details can be found on [1]. This overview is provided per institute.

University of Edinburgh

At The University of Edinburgh, there were five dissertations across a range of topics. David Xiao investigated whether gas phase temperatures in compartment fires are the same in full scale and reduced scale experiments. It is often expected that gas temperatures in compartment fires are the same at full scale and in reduced scale experiments, however it has been observed that this only applies to well ventilated compartment fires, and not to under ventilated compartment fires. Using numerical simulations, three methods for how to adjust reduced scale data to predict full scale temperatures were investigated, and the best method was identified. Samiksha Bastola undertook a cost benefit analysis to evaluate the societal implications of installing interlinked fire alarm systems in dwellings across Scotland and England using statistical data. The finding underscored the challenges with accessing appropriate data as well as the need for holistic approaches to fire safety. Luis Urbina Pita assessed the fire hazards present in the domestic gas system operating with hydrogen to support decision making in a potential transition. Using Failure Mode and Effects analysis and developing Fault Tree analyses, causes of failures and the consequences were identified. Interestingly the current available information was not sufficient to allow a cost benefit analysis to be undertaken.

Two theses were undertaken to investigate the challenges to fire safety strategies posed by engineered timber buildings. Sadia Hanif undertook work to identify the ignition and burning of timber in a ceiling orientation when subjected to an impinging plume. Specifically, the impact of downstand

beams on the time to ignition and feedback to the floor was investigated. Rebekka Marteinsdottir studied the initiation and propagation of smouldering of timber. This experimental work explored the effects of the energy balance and grain orientation. The study successfully quantified smouldering propagation rates and depths under different, relevant conditions, shedding new light on the factors that may influence smouldering in mass timber structures.

Ghent University

At Ghent University, there were two master's dissertations where multi-phase aspects with liquids played a central role. One study (by Chiraz Alili) focused on low-frequency oscillatory fire behaviour as observed in mechanically ventilated airtight compartments, while the other (by Pedro Vargas Rolon) considered spray cooling of hot surfaces, with fire control applications in mind. Both studies were fundamental in nature, using CFD as a tool to advance fire safety science, with Tarek Beji as main supervisor. Tillmann Bruder, under supervision of Ruben Van Coile, performed a cost optimization study on the use of passive fire protection measures in the context of structural fire safety in infrastructure tunnels. Mahsa Zeinolabedini and Farith Hinojosa Coca revisited a range of empirical correlations as commonly used in fire-safety engineering, the former in free-burn scenarios and the latter for compartment fires. They performed validation studies, using CFD simulations, under supervision of Georgios Maragkos. And Lakmini Abey Suriy assessed the potential of zone models as tool in the context of the design of smoke and heat control systems, with Bart Merci as academic supervisor.

As usual there were also dissertations in collaboration with associated partners and industry partners. This year Bart Merci supervised a dissertation, performed by Yingzhu Wang at ETH Zürich (with Andrea Frangi and IMFSE alumnus Chamith Karannagodage as supervisors), on the development of simplified zone model calculations in the context of fire dynamics in timber compartments. Lakmini Abey Suriya also worked on zone models for use as a tool in early design phases of smoke and heat control systems, supervised by Bart Merci and Matteo Pachera (Sweco).

Universitat Politècnica

At Universitat Politècnica de Catalunya (UPC) two master's dissertations were completed on CFD modelling of industrial fires and explosions. One of them (by Vanessa May Josol with Alba Àgueda as main supervisor) focused on investigating a new approach to simulating jet fires by using a combination of FLACS and FDS software. The other (by Pouria Safari with Eulalia Planas as main supervisor) explored OpenFOAM's capability to simulate the different stages involved in Boiling Liquid Expanding Vapour Explosions (BLEVEs).

Additionally, at UPC, two more master's dissertations were conducted on the topic of wildland-urban interface (WUI) fires. Matheus Pontes (under the co-supervision of Elsa Pastor and the IMFSE alumnus Pascale Vacca) applied a performance-based design (PBD) methodology to identify the vulnerabilities and propose solutions to enhance property protection of a campsite located in a touristic WUI in Costa Brava (Spain), as part of the EU-supported WUITIPS project aimed at improving safety in touristic areas exposed to wildfire risk. The other student, Saurabh Kumar Singh (under the supervision of Pascale Vacca) focused on refining and improving the Urban Interface Index (WUIX), a vulnerability assessment tool for the WUI mesoscale, using high-resolution satellite imagery and machine learning techniques.

An additional master's dissertation was carried out by Ashwant Singh on the topic of WUI fires in collaboration with the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia (with Raphaëlle Blanchi and Justin Leonard as main supervisors at CSIRO and Elsa Pastor and

Pascale Vacca as UPC co-supervisors). The aim was to develop feasibility research of WUI PBD using a CSIRO experimental case reproduced in FDS.

At UPC, Eulalia Planas, in collaboration with Santos Bendicho from the industry partner SODECA co-supervised the master's dissertation developed by Anis Jayaram. This dissertation explored, using CFD tools, the interaction of ventilation systems with flammable and toxic gases released from electric vehicle batteries and leaks from hydrogen vehicle tanks in enclosed car parks, varying ventilation configurations to produce flow patterns to analyse changes in toxicity and flammability.

Lund University

At Lund University, two master dissertations related to the topic of wildfire safety through modelling tools. One student (Amina Labhiri) investigated the use of simulations to inform evacuation guidelines in touristic areas. This thesis was supervised by Enrico Ronchi and was part of the EU-supported WUITIPS project aimed at improving safety in touristic areas exposed to wildfire risk. Another student (Fredrik Buhk) conducted his thesis under the supervision of Patrick van Hees in collaboration with the Federal Institute for Materials Research and Testing (BAM) in Germany, with Anja Hofmann-Böllinghaus as co-supervisor. The thesis investigated the use of a particle model of the wildland-urban interface part implemented in the Fire Dynamics Simulator (FDS) to numerically analyse the influence of the local vegetation on the surface fire spread. Another student (Maria Binte Mannan) also conducted her thesis in collaboration with BAM under the supervision of Patrick van Hees and Bernhard Schartel, focusing on the fire behaviour and fire stability of wood species and joint types. This thesis was experimental and included a total 160 small-scale tests (100 cone calorimeter tests and 60 fire stability tests) which helped identifying key influential factors during the fire tests.

Lund University has also a longstanding collaboration with the European Organization for Nuclear Research (CERN) in the domain of fire safety. This resulted in several master thesis conducted at CERN by IMFSE students over the years (often alongside IMFSE alumni now working at CERN). This year, one student (Maskim Labkouski) conducted his thesis on the topic of Life cycle analysis of fire detection systems under the supervision of Margaret McNamee and Brecht Debrouwere from CERN. The thesis adopted a Present Net Value methodology to assess the costs and benefits of replacing current fire detection systems. Another student (Cheuk Lam Chung) conducted a study concerning the evacuation of the Compact Muon Solenoid facility at CERN (co-supervisors at CERN were Oriol Rios, Saverio La Mendola and Lorenzo Contini). The thesis included the collection of human behaviour data from an evacuation drill in the facility as well as their use for evacuation simulations.

Two more thesis topics related to the area of evacuation in collaboration with industry partners, both under the supervision of Enrico Ronchi. One thesis (by Ahmed El Sharkawi) was in collaboration with GAE Engineering and investigated evacuation safety in arenas through the study of crowd density. Another thesis (by Yuyao Xue) was in collaboration with OFR (Michael Spearpoint as co-supervisor) and focussed on the suitability of phased evacuation strategies for multi-purpose residential buildings which was investigated through evacuation simulations.

It is our hope that this article served as an invitation to read more on these dissertations [1] and to explore our IMFSE programme in more detail [2].

References

[1] <https://imfse.be/theses>

[2] <https://imfse.be/>