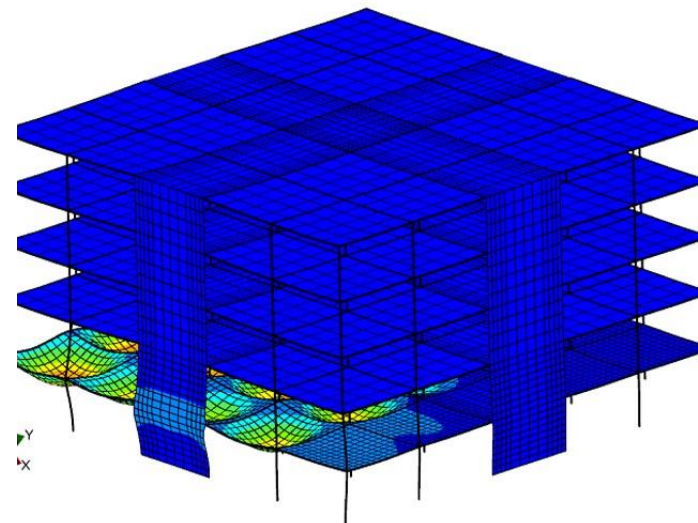
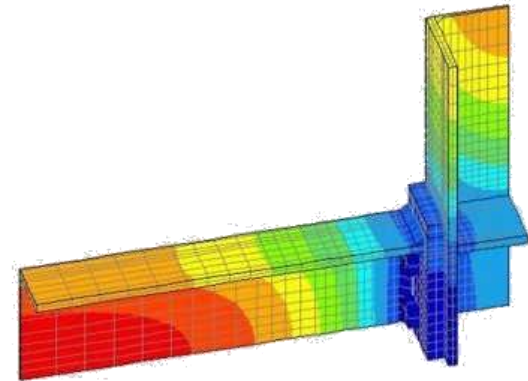


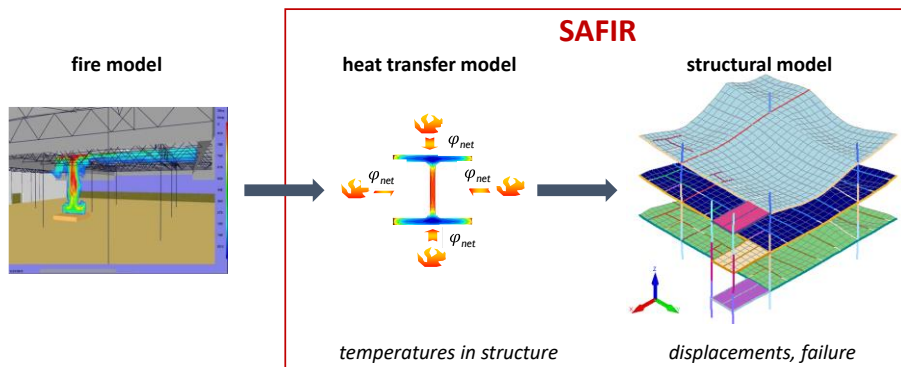
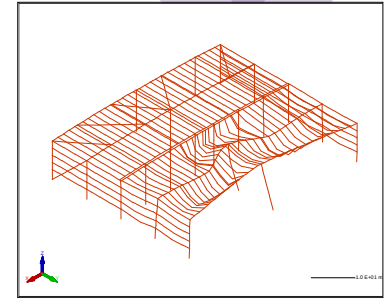


SAFIR[®]



Description of SAFIR®

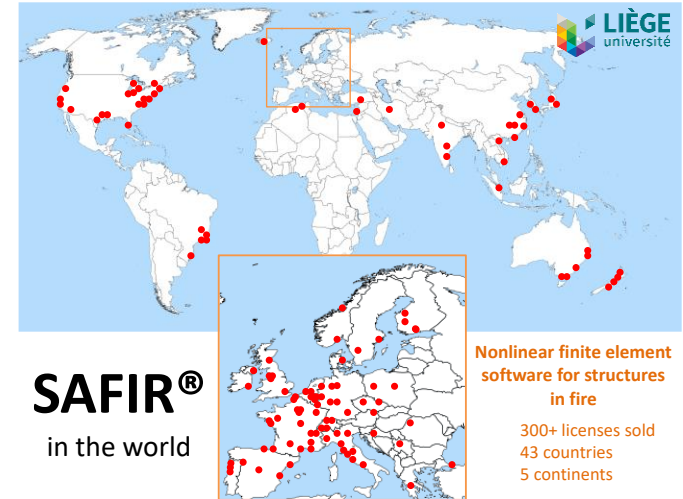
SAFIR is a **computer program** that models the **behavior of building structures subjected to fire**. The structure can be made of a 3D skeleton of linear elements such as **beams and columns**, in conjunction with planar elements such as **slabs and walls**. Volumetric elements can be used for analysis of details in the structure such as **connections**. Materials such as **steel, concrete, timber, aluminum, gypsum** or thermally insulating products can be used separately or in combination in the model.



Process in a SAFIR analysis

1. Thermal attack from the **fire** is an input
2. SAFIR computes the evolution of the **temperatures** in the sections
3. Then, SAFIR computes the **mechanical response** of the structure at elevated temperatures, taking into account the thermal elongations as well as the reduction of strength and stiffness in the materials

SAFIR is widely used in the structural fire engineering community



- Licensed software
- Academia
- Industry and design offices



Applications for buildings

JTI Headquarters (INGENI SA)

The current issue and full text archive of this journal is available on Emerald Insight at:
www.emeraldinsight.com/2040-2317.htm

Advanced analyses of the membrane action of composite slabs under natural fire scenarios

A case study of the JTI headquarters

Lorenzo Lelli and Jonas Loutan
INGENI SA, Carouge, Switzerland

Membrane
action of
composite
slabs

Received 20 December 2016
Revised 1 March 2017
Accepted 2 May 2017



Four Pancras Square (Trenton Fire)

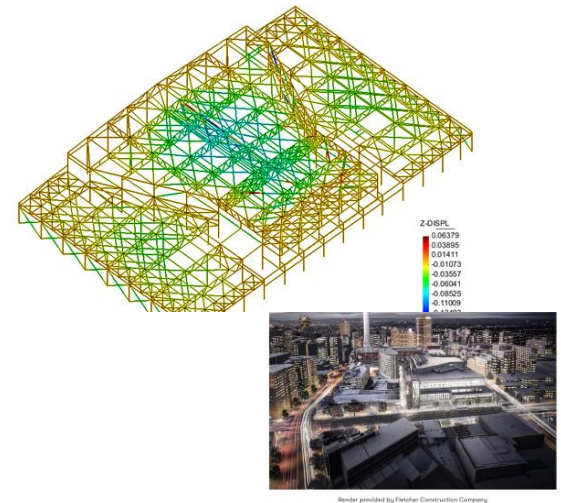
Structural fire engineering
A structural fire strategy for a weathering steel building

A structural fire strategy for an exposed weathering steel-framed building

Danny Haydon Engl, CEng, MEng Associate, Clean Fire & Risk UK, Oxford, UK	Steven Beattie MEng, CEng Fire Engineer, Clean Fire & Risk UK, London, UK	David Bingham MEng, CEng, MSc, FEng Design Director, AWT, London, UK
Ben McCall MEng, ACFire Fire Engineer, Clean Fire & Risk UK, Oxford, UK	Eden O'Loughlin MSc, CEng, MEng Senior Fire Engineer, Argus Ltd	Adam Taylor MEng, CEng, MEng Director, Tenthord Fire Ltd, UK



NZ International Convention Center (Holmes)



Holmes was engaged to undertake structural fire engineering investigations of the long span steel trusses which supported the roofs. The structural system of the roof consists of a complex three-dimensional interconnected truss system which featured heavy welded structural steel members, spanning up to 90m. Holmes led the structural fire investigation in conjunction with other investigative works by other experts, engineers and consultants, to determine if the roof trusses could still be retained and re-used.

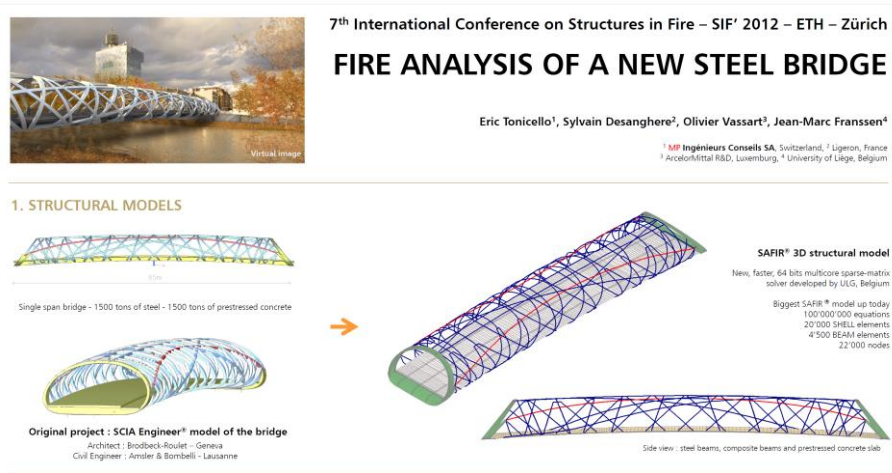
Holmes undertook extensive site investigations to map out the extent of heating of the structure by reviewing video footage of the entire fire, damage observations of post-fire damage and observations of the post fire state of the reactive fire protection coatings. This enabled a detailed "heat map" to be created of the heating of all the roof trusses.

This data was then used to analyse the entire roof structure using an advanced non-linear thermal and structural finite element program, S&R. The advanced analysis was intended to replicate the heating and cooling of the entire structure, to analyse the internal forces in the structural member considering loss of strength and expansion of the structure. This analysis was undertaken to identify which elements would have had their structural capacities exceeded, and to determine where locked-in internal stresses have developed due to the heating and cooling of the fire. The structural fire analysis involved modelling a travelling fire on the roof based on the mapping of the fire locations based on a full time-lapse video footage.

<https://holmesanz.com/perspectives/post-fire-investigation/>

Applications for other structures

Wilsdorf bridge in Switzerland (MP Ingenieurs Conseils)



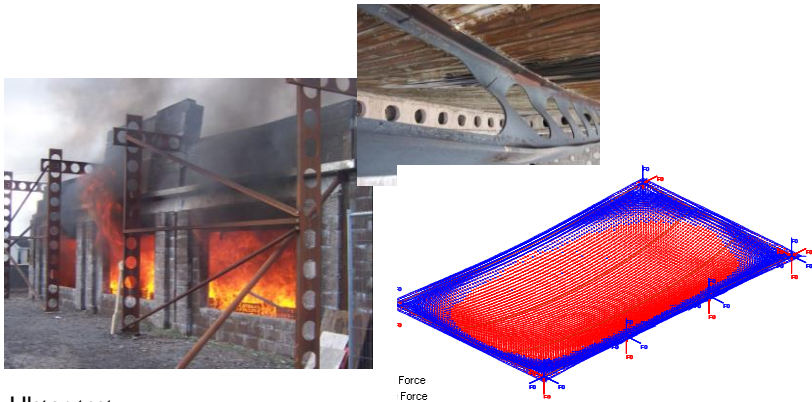
Sport Hall in Finland (Markku Kauriala & Jensen Hughes)



Stadiums:

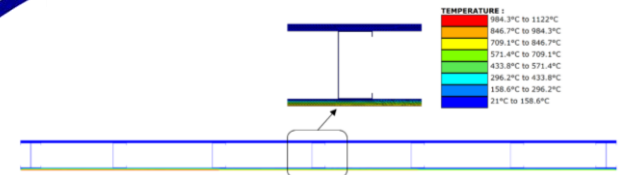
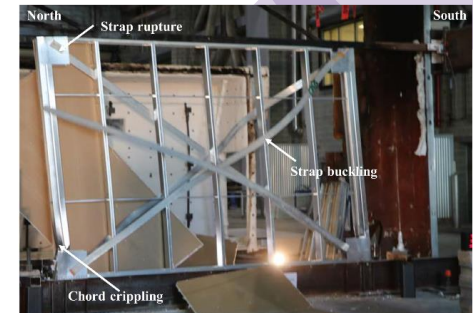
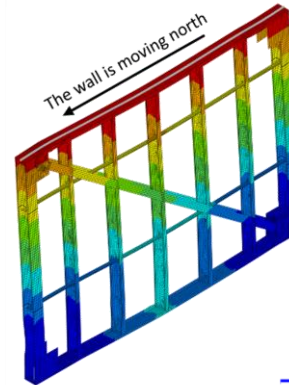
- Helsinki Olympic stadium (Markku Kauriala, ASFE 2015 Dubrovnik)
- Bristol Arena in the UK (Buro Happold, IFireSS 2017 Naples)

SAFIR: examples of publications

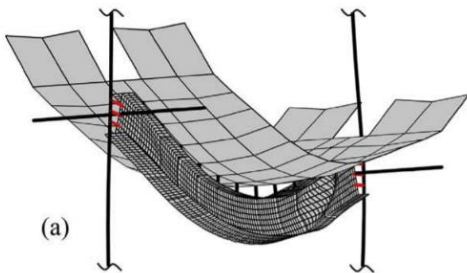


Ulster test.

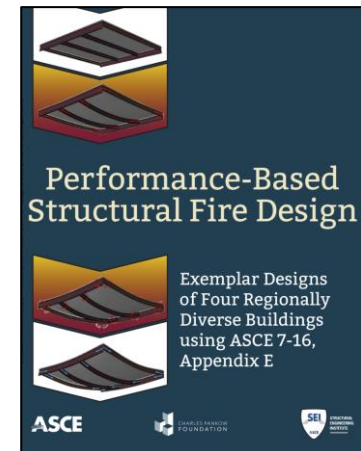
Vassart et al. (2012). *Proceedings of the ICE: Structures and Buildings*, 165(7), 327–334



Ni, Yan, Hoehler, Gernay. (2022). *Thin-Walled Structures*, 171, 108733



Lehigh University team. <https://doi.org/10.1016/j.jcsr.2020.105946>



Prepared by the Structural Engineering Institute (SEI) of the American Society of Civil Engineers (ASCE)

SAFIR Day

SAFIR® Day

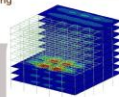
15 September 2023

Presentations & discussions with
SAFIR users from industry and academia

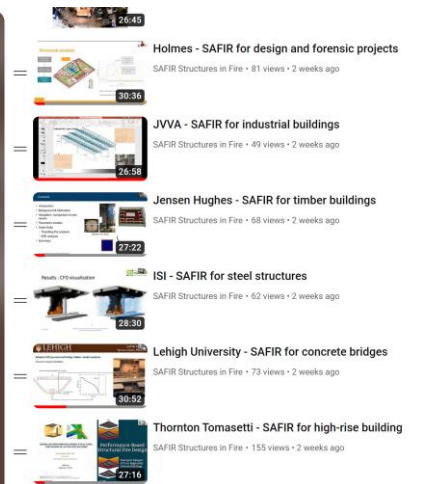
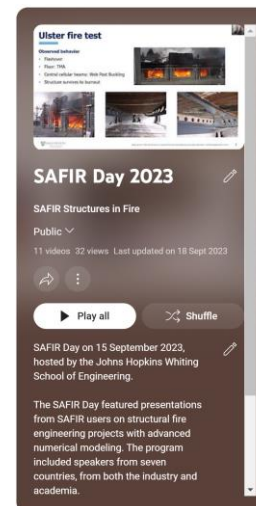
1st edition
Online
8am-3pm NY / 2pm-9pm Brussels



TIME	TIME		Speaker	Affiliation	Title
	EDT (NYC)	CEST (BRU)			
8:00	14:00		JEAN MARC FRANSSSEN	Liege University	Thermal and structural modeling of voided concrete slabs
8:30	14:30		JEREMY CHANG & LINUS LIM	Holmes Australia & NZ	Utilisation of SAFIR for structural fire assessment in forensic and design applications
9:00	15:00		ERIC TONICELLO & JULIEN DUBOC	ISI Sarl	Structural assessment and optimization of steel and composite structures in Switzerland
9:30	15:30		ROBERTO CEDDERINA	JVVA Structural	Experiences and lessons learned from industrial buildings
10:00	16:00		SFE at UGENT	Ghent University	Bench-scale experiments to full-scale tunnel cross-sections: recent applications at Ugent
10:30	16:30		LORENZO LELLI	INGENI	Advanced analysis of the membrane action of composite slabs under natural fire scenarios: A case study of the new JTI headquarters
BREAK					
12:00	18:00		NICOLA TONDINI	Trento University	Modeling the fire performance of steel and steel-concrete composite bridges
12:30	18:30		MIKKO SALMINEN	Jensen Hughes	Thermal and structural analysis of timber columns in travelling fire - Case study
13:00	19:00		JENNY SIDERI	Thornton Tomasetti	Exemplar performance-based design of a high-rise building
13:30	19:30		NEGAR KHORASANI	University at Buffalo	Numerical modeling of reinforced concrete tunnel slabs during heating and cooling phases of fire
14:00	20:00		SPENCER QUEL	Lehigh University	Thermo-structural modeling of a precast, prestressed bulb-T bridge girder with fire-induced spalling
14:30	20:30		THOMAS GERNAV	Johns Hopkins University	Modeling of large-scale fire tests on composite floors developing tensile membrane action



- 12 presentations by SAFIR users
- 130 participants
- Videos available on YouTube channel
<https://www.youtube.com/@safirstructuresinfire2367>





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