附錄三 相關國際組織交流報告

- ASTM E05
- FPRF
- IAFSS
- Fire Safety Journal

FORUM Meeting, Paris, France, September 2013

ASTM Committee E05 Liaison Report

Marc Janssens
Chairman of ASTM E05

ASTM COMMITTEE E05 STRUCTURE

- Division 1
  - E05.11 on Fire Resistance (ASTM E119)
  - E05.14 on External Fire Exposure Tests
  - E05.15 on Furnishings and Contents
  - E05.17 on Transportation
- Division 2
  - E05.21 on Smoke and Combustion Products (ASTM E1354)
  - E05.22 on Surface Burning (ASTM E84)
  - E05.23 on Combustibility

COMMITTEE STRUCTURE (CONTINUED)

- Division 3
  - E05.31 on Terminology and Services/Functions
  - E05.32 on Research (Chaired by Matt Bundy of NIST)
  - E05.33 on Fire Safety Engineering (ASTM E1355)
- Division 4—ISO/TC92 TAGs
- Administrative
  - E05.90—Executive Committee (Added Research Executive)
  - E05.91—Planning and Review
- Anybody can attend the semi-annual ASTM meetings

ASTM E05 MEETINGS AND MEMBERSHIP

- Last meeting was at ASTM International headquarters in West Conshohocken, PA, June 17-20, 2013
- Next meeting will be at Hyatt Regency Jacksonville Riverfront, Jacksonville, FL, December 9-12, 2013
- Why not become a member of ASTM E05?
  - $75 annual dues
  - Members get one volume of the ASTM book of standards free of charge (nearly all fire standards are in volume 04.07)
  - Available in three formats (hardcopy, CD and online)
  - No need to attend meetings

ACTIVITIES
ASTM E84 Mounting Methods (1)

- ASTM E84 is the primary test method in the US codes
- Apparatus is an 8.7 x 0.45 x 0.31 m "tunnel"
- 7.6 x 0.51 m specimen is mounted in the ceiling
- 79 kW flame heats the specimen at one end
- Air flows through the tunnel at 1.2 m/s
- Measurements during 10 minute test:
  - Flame tip location vs. time ⇨ Flame Spread Index
  - OD in duct ⇨ Smoke Developed Index
- FSI ~5 for inert board and SDI ~100 for red oak

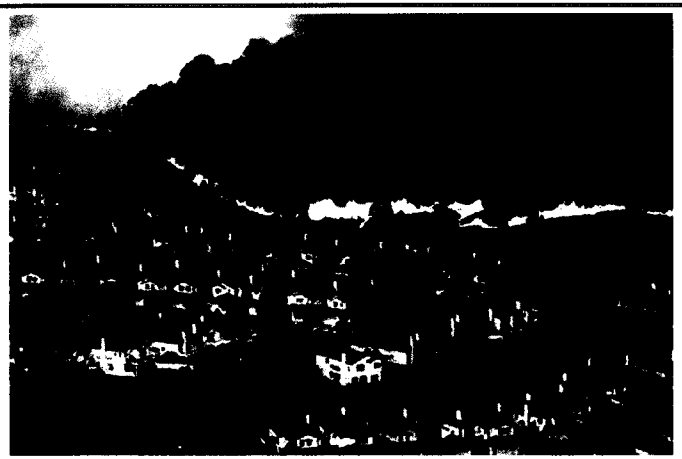
ACTIVITIES
ASTM E84 Mounting Methods (2)

ACTIVITIES
ASTM E84 Mounting Methods (3)

Specimen preparation and mounting methods:

- ASTM E2231: Pipe and Duct Insulation Materials
- ASTM E2404: Wall or Ceiling Coverings
- ASTM E2573: Site-Fabricated Stretch Systems
- ASTM E2579: Wood Products
- ASTM E2599: Reflective Insulation, Radiant Barrier and Vinyl Stretch Ceiling Materials
- ASTM E2688: Tapes
- ASTM E2690: Caulks and Sealants

ACTIVITIES
Wildland-Urban Interface Tests



ACTIVITIES
Wildland-Urban Interface Tests (2)

- Fires in the Wildland-Urban Interface (WUI) have been a major problem for many years
- California has probably been the hardest hit by this problem ⇨ New regulations in 2007 CBC
  - SFM Std 12-7A-1: Wall Siding and Sheathing
  - SFM Std 12-7A-2: Exterior Windows
  - SFM Std 12-7A-3: Under Eave
  - SFM Std 12-7A-4: Decking
  - "Ignition Resistant" ⇨ ASTM E2768 FSI ≤ 25

ACTIVITIES
Wildland-Urban Interface Tests (3)

- In 2009 ASTM E05 first published ASTM E2707 (similar to SFM Std 12-7A-1)
- More recently a burning brand test for decks (ASTM E2726/E2726M) was developed in response to California OSFM recommendations
- ASTM E05 is working on test methods for
  - Under-deck fire test response of deck materials
  - Resistance of vents to entry of embers/flame
  - Roof vent response to wind-blown embers/flame
  - Flammability of eaves and horizontal projections

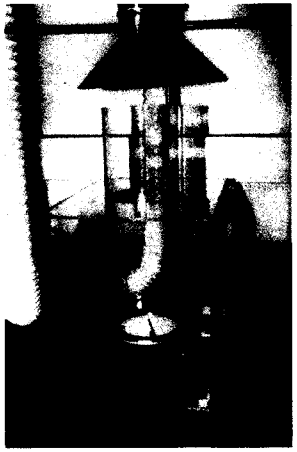
ACTIVITIES
RIP Cigarette Test (1)

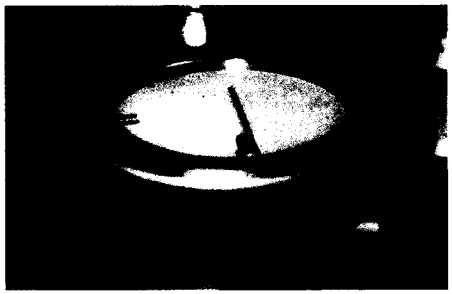
- Cigarettes are a leading cause of U.S. home fire fatalities, killing 500-700 people per year
- The most common initiating event is the smoldering of a bed or upholstered furniture
- Approaches to reduce the losses
  - Cigarette-ignition resistant mattresses & furniture
  - Reduce cigarette propensity to ignite furnishings
- The second approach requires a test to quantify the ignition strength of cigarettes

ACTIVITIES
RIP Cigarette Test (2)

- NIST developed such a method in the 1990s
- The NIST method was the basis for ASTM E2187, which was first published in 2002
- All cigarettes for sale in the U.S. now have a reduced propensity to ignite soft furnishings
- Cigarettes that meet these criteria are also referred to as "fire-safe" (misnomer)
- NFPA estimates that by the time the data is in from 2011, deaths due to cigarette-ignited fires will be down by 30% from 2003

ACTIVITIES
RIP Cigarette Test (3)





Source: ASTM E2187

DISSIMINATION OF RESEARCH RESULTS

- Two-hour Research Review session (at every meeting)
  - Topics at the June 2013 meeting in West Conshohocken, PA
    - Javier Treviño of Priest and Associates on use of gas temperature measurements to estimate heat release rate in room fire tests
    - Anthony Hamins on fire research activities at NIST
    - John Hall on fire research activities at NFPA/NFPRF
    - Sergey Dorofeev on modeling of sprinkler tests at FM Global
- Symposia (generally every two years)
  - Next symposium topic is "Urban-Wildland Interface Fires", in conjunction with E05 meeting in Anaheim, CA, June 15-18, 2015

QUESTIONS?

http://www.astm.org/COMMIT/COMMITTEE/E05.htm

THE INTERNATIONAL FORUM OF FIRE RESEARCH DIRECTORS

FORUM

LIAISON REPORT FOR FPRF: FIRE PROTECTION RESEARCH FOUNDATION

ANNUAL MEETING

17 – 20 SEPTEMBER 2013 PARIS, FRANCE

Casey C. Grant, Research Director
Fire Protection Research Foundation
Quincy, Massachusetts USA

THE FIRE PROTECTION RESEARCH FOUNDATION

INTERNATIONAL FORUM OF FIRE RESEARCH DIRECTORS

FORUM

LIAISON REPORT FOR FPRF: FIRE PROTECTION RESEARCH FOUNDATION

AGENDA

1)Understanding the Foundation

2)Agenda Setting (i.e., research planning)

3)Research Projects

4)Benchmarking (i.e., symposia)

1) Understanding the Foundation

FPRF: Role of the Foundation

- Plan, manage and communicate research in support of the NFPA mission
- Independent charitable organization
  - Formed by NFPA in 1982
  - Intended to provide data to support the needs of NFPA codes & standards
  - Research funds come primarily from:
    - Private and public sector consortia
    - Grants and government sources (e.g. DHS S&T, DOD, DOE, DOT, FEMA AFG, NIOSH, NIST, NSF, etc)
    - Multiple other sources (including NFPA)

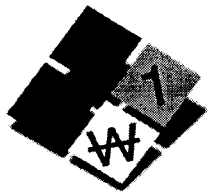
1) Understanding the Foundation

FPRF: How the Foundation Operates

I. Agenda Setting – research planning in emerging areas

II. Research Programs –
  - Research projects to meet the needs of NFPA Committees and others
  - Projects range from small literature search type studies to major fire testing programs

III. Benchmarking – state of the art symposia



1) Understanding the Foundation

FPRF: Project Participants… Who are they?

- Funding (Sponsors): *Where does it come from?*
  - Manufacturers, trade associations, NFPA, federal agencies, research organizations, nowhere, etc…
- Contractors: *Who Does the Work?*
  - Consultants, research organizations, test labs, universities, NFPA Fire Analysis, volunteers
- Advisory Oversight: *Project Technical Panel*
  - Typically small (6 to 15)
  - Meet at important stages of project (start/end/other)

1) Understanding the Foundation

FPRF: Research Process (for "Advisory Service" Proj)

1) Project Technical Panels:
   - Code enforcers, code writers, subject matter experts, principal sponsors, NFPA staff liaisons
   - Determines technical details of the project, oversees and provides guidance to contractor
2) Research Performed:
   - Other organization obtains funding and leads project
   - FPRF in supporting role
3) Research Reports Published:
   - Final reports published and made available to all

1) Understanding the Foundation

FPRF: Project Characteristics and Ideas

- Characteristics of Foundation Projects: (collaboration, cost sharing, independence, pipeline to implementation, communications network)
- Project Ideas:
  - TC struggling with an issue, via staff liaison
  - Industry wants to introduce new technology into standard; needs data
  - Two opposing views on an issue and data needed
  - Data presented is not trusted by committee
  - Emerging technical issue – e.g. alternative energy
  - TC establishes ongoing research planning activity

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2) Agenda Setting (i.e., Research Planning)

Traditional Project Topic Areas

- Hazardous materials – spacing
- Detection and alarm –performance in given fire scenarios
- Sprinklers – fire tests of commodities
- Electrical – performance in place
- Fire service – PPE test methods
- Risk assessment in codes and standards development

2) Agenda Setting (i.e., Research Planning)

FPRF: 5 Year Strategic Research Agenda

Focusing on the following seven areas:

- Building furnishings, contents, & configurations
- Advanced fire detection & suppression systems
- Advanced fire fighting equipment and tactics
- Aging of fire and electrical safety systems
- Alternative fuels and energy sources
- Growing aging & disabled population
- Environmental considerations

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3) Research Projects

FPRF Projects (completed since Jan 2013)

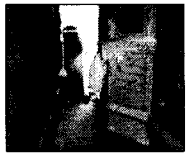
- For Emergency Responders
  - Emergency Response to Electric Vehicle Battery Hazards
- Hazardous Materials
  - Hydrogen Refueling Code Gap Analysis
- Fire Protection Systems – Sprinkler and Fire Alarm
  - Exposed Expanded Plastics Sprinkler Protection
  - Lithium Ion Battery Storage Hazard Characterization
  - Risk based Decision Support Tool for Managing Unwanted Alarms
  - Evaluating Water Additives for Fire Control and Vapor Mitigation
  - Sprinkler Protection with Cloud Ceilings
- Other
  - Total Evacuation Strategies for Tall Buildings
  - WUI Land Use Policy Workshop
  - Evaluating Occupant Load Factors for Business Operations

3) Research Projects

FPRF Projects (initiated in 1st half of 2013)

- For Emergency Responders
  - Liquid Integrity Evaluation Techniques for First Responder Ensembles
  - Evaluation of Fire Flow Methodologies
  - Assessment of PPE Care & Maintenance
  - Real Time Fire Fighter Particulate Sensor
  - Evaluation of Green Building Components for Fire Fighter Safety

- Hazardous Materials
  - Technical Basis for Separation Distances in NFPA Codes/Standards
  - Heavy Snow Loads for Fuel Gas Code Facilities
- Suppression
  - Home Fire Sprinkler Cost Assessment Revisited



3) Research Projects

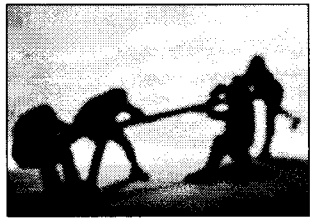
FPRF Projects (initiated in 1st half of 2013) *continued*

- Building and Life Safety
  - Determining Self-Preservation Capability in Pre-School Children
  - Fire Hazards of Exterior Wall Assemblies Containing Combustible Components
  - Fire Safety Challenges of Tall Wood Buildings
  - Glass Boarding Bridges
  - Documenting Non-Fire Hazard Provisions in NFPA Codes and Standards that Address Life Safety

3) Research Projects

Student Project Initiative

- Complete
  - Evaluating Occupant Load Factors for Business Operations, University of Cantabria (Spain) and IIT
- Underway
  - Determining Self-Preservation Capability in Pre-School Children, Technical University of Denmark
- Fall 2013 Projects
  - Evaluating Occupant Load Factors for Ambulatory Healthcare Facilities
  - Hybrid Water Mist Fire Protection Systems



3) Research Projects

Developing Projects

- Phase II's – Water additives, detection in warehouses, extinguishing agents and cultural relics, timber buildings fire hazards/exterior wall fire hazards, cloud ceilings
- Grant Proposals
  - Roadmap for SMART fire fighting
  - More cooking fire research
  - Bangladesh training resources
- PIRG Projects – more lithium ion battery work, ESFR and obstructions

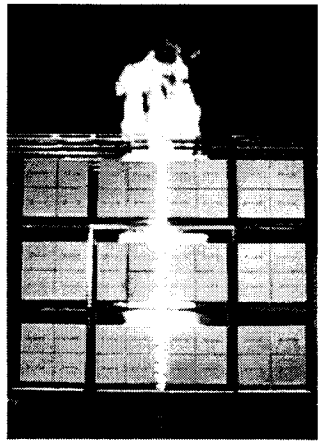
3) Research Projects

Case Studies

- Projects
  - Storage Protection for Lithium Ion Batteries
  - Decision Support Tool for Unwanted Alarms
  - "Shower Test"
  - Impact of NIST NCST Recommendations

Flammability Characterization of Stored Lithium Ion Batteries

- PIRG sponsored, FM Global partner
- Major industry and media attention; many collaborators
- Final answers for storage protection yet



Decision Support Tool for Unwanted Alarms

- Sponsored by: NFPA (donation of technical services), CSAA, SIA, ESA, AFAA, NEMA – true collaborative effort
- Developed a test ready risk management tool for use by FDs (spreadsheet)
- Estimate effects on costs and losses of varying strategies for commercial properties – response verification most effective
- Now working on an initiative to test and improve the tool with metro FDs/CSAA

Improved Liquid Integrity Evaluation Techniques for First Responder Ensembles

- Improve procedures for evaluation of barrier protective clothing for emergency responders hazardous liquid exposure
- Addressing repeatability and reproducibility of test methods.
- Directly related to PPE standards.
- Funded by CTTSO; 20 month project; Led by International Personal Protection.

Pilot Demonstration of an Impact Evaluation Protocol

- In support of NIST recommendations for National Construction Safety Team (NCST)
- Evaluation of impact of recommendations from the NCST report on a single incident
- Focus on recommendations from Station Nightclub Fire
- Funded by NIST; one year study; based on NFPA survey

INTERNATIONAL FORUM OF FIRE RESEARCH DIRECTORS

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4) Benchmarking (i.e., Symposia)

FPRF Symposia, Conferences, etc…

- The Next Five Years in Fire and Electrical Safety
  - 13-14 November 2013, Wash DC USA
- SupDet 2014
  - 4-7 March 2014, Orlando Florida USA
  - Call for Papers now out (until 15 October 2015)
- Global Research Update: High Challenge Storage Protection
  - 22 May 2014, London England
  - Program Highlights;
    - Emerging storage challenges; latest global research; global insurance perspective
  - Program still being finalized

Contact Information:

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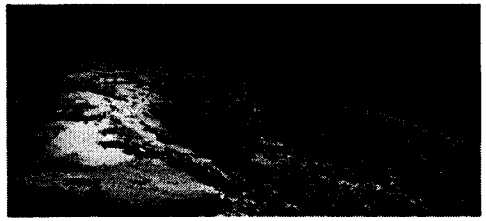
Fire Protection Research Foundation

One Batterymarch Park, Quincy, MA USA 02169-7471

Phone: 617-984-7284 Email: cgrant@nfpa.org

FPRF Website: www.nfpa.org/foundation

THE FIRE PROTECTION RESEARCH FOUNDATION



Liaison Report to the FORUM

International Association of Fire Safety Science (IAFSS)

Anthony Hamins
September 17, 2013

Presentation Outline

- Symposia Summary
- 11th Symposium Plans
- FORUM Student Travel Awards
- Rejuvenated IAFSS website
  - Digital Archive
  - Newsletter
- IAFSS Membership

Summary of Recent IAFSS Symposia

10th International Symposium on Fire Safety Science (September 10-14, 2009)
University of Maryland, College Park, MD, USA
314 registrants (20% Asia/Oceania, 40% USA, 40% Europe)
110 papers (201 submitted) & 121 posters
6 Workshops/Student Networking Session

11th International Symposium on Fire Safety Science (February 9-14, 2014)
University of Canterbury, Christchurch, New Zealand
205 papers submitted (approximate acceptance rate of 55 % to 60 %)

12th International Symposium on Fire Safety Science (2017)
University of Lund, Sweden

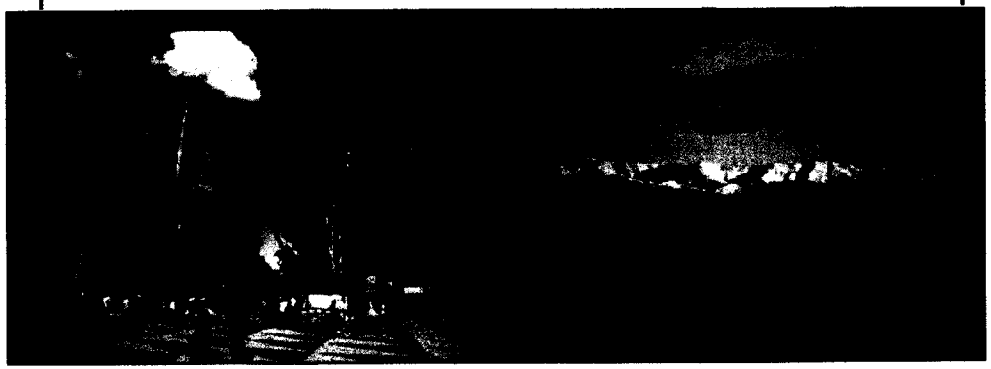
13th International Symposium on Fire Safety Science (2020)
Location in the Americas
Specific site to be determined

11th International Fire Safety Science Symposium

UNIVERSITY OF CANTERBURY

Location: University of Canterbury
Christchurch New Zealand

Dates: 10-14 February 2014



11th International Symposium on Fire Safety Science

February 9-14, 2014
University of Canterbury, Christchurch, New Zealand

Submitted Papers (205)

- **Ignition, Flame Spread** 34 papers
- **Compartment Fire Dynamics** 29 papers
- **Structural Fire Performance** 21 papers
- **Evacuation and Human Behavior** 21 papers
- **Forest (wildland) fires** 18 papers
- **Fire Risk Analysis and Statistics** 16 papers
- **Suppression** 16 papers
- **Flame Retardants and Advanced Materials** 14 papers
- **Fire Chemistry and Toxic Hazards** 9 papers
- **Smoke Control and Detection** 8 papers
- **Explosions and Industrial Fires** 8 papers
- **Special Applications** 7 papers
- **Fire Safety and Sustainable Design** 4 papers
- **Special Track** 30 papers

11th International Symposium on Fire Safety Science

February 9-14, 2014

University of Canterbury, Christchurch, New Zealand

Keynote Speakers

•Bart Merci, Ghent University, Belgium, "Computer Modeling for Fire and Smoke Dynamics: a Help or a Burden?"

•Yuan Hu, USTC, China, "Layer Nano-Fillers: A Review on the Fire Safety of Polymeric Nanocomposites and the Mechanism"

•Jose Torero, University of Queensland, Australia, "Revisiting the Compartment Fire"

•Sam Manzello, NIST, USA, "Enabling the Investigation of Structure Vulnerabilities to Wind-Driven Firebrand Showers in Wildland Urban Interface (WUI) Fires"

•One more plenary speaker is to be selected by the Host Committee.

•The recipient of the Emmons Award to be selected by the Awards Committee.

11th International Symposium on Fire Safety Science

February 9-14, 2014

University of Canterbury, Christchurch, New Zealand

Symposium Workshops (Sunday, 9 February 2014)

•Wildfires and Climate Change

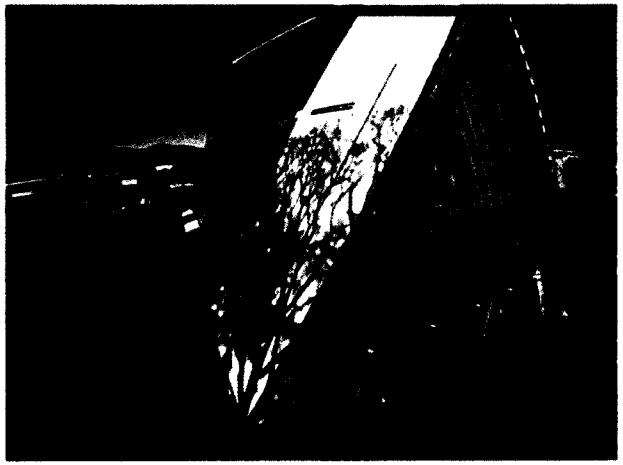
•Multi-Objective Fire Safety System Design – Economy, Sustainability and Aesthetics

•Education

•Benchmarking / Data sharing

•New Approaches for Evacuation Modeling: return to the origins and walk to the Future

Symposium Banquet Transitional Cathedral



Options for Monday evening

Optional Program
International Antarctic Centre

11th international Symposium for Fire Safety Science

Call for Posters and Fire Science Images

February 10-14, 2014 - University of Canterbury, New Zealand

Research of Interest

The International Association for Fire Safety (IAFSS) sponsors the world's premier sympo

Posters and images
Key dates

Oct 15, 2013 - Submission of Poster Abstracts (deadline)

Nov 15, 2013 - Poster Abstract Acceptance

Jan 20, 2014 - Image submission Deadline

- Membership
  - Membership Registration
  - Student Membership Registration
- Officers & Bylaws
- Awards
- Digital Archive
- Fire Technology
- Education Subcommittee
  - Curricula

Awards

The IAFSS makes the following Awards every 3 years. The Emmons Award is given by the Symposium Programme Committee whilst the other four are given by the IAFSS Awards Committee. Details of all Awards are listed and given below:

- Emmons Award
- Kunio Kawagoe Gold Medal
- Philip Thomas Medal of Excellence
- FORUM Student Travel Awards for the IAFSS Symposium
- Best Thesis Award "Excellence in Research
- The Awards Committee

Emmons Award

Award, Eligibility and its Privileges

The award consists of a bronze plaque, travel expenses, and an honorarium. The Emmons Award is presented for distinguished lifetime achievement in Fire Safety Science; it is not a best paper award. In addition to the plenary lectureship, the award consists of a bronze plaque, travel expenses, and an honorarium.

Nomination Process

The nomination process is handled by the Symposium Program Committee. Nominations are sought from

FORUM Student Travel Awards to the IAFSS Symposium

These Awards are sponsored by the International FORUM of Fire Research Directors (http://fireforum.org/), a group of the Directors of fire research organisations thr the world, which aims to reduce the burden of fire (including the loss of life and property, and effect on the environment and heritage) through international cooperation on fire research. The award re excellence in an IAFSS symposium paper in the field of fire safety science by a student making a sig contribution to that paper.

FORUM

FORUM Student Travel Awards for the 10th IAFSS Symposium

These Awards are sponsored by the International FORUM of Fire Research Directors (http://fireforum.org/), a group of the Directors of fire research organisations throughout the world, which aims to reduce the burden of fire (including the loss of life and property, and effects of fire on the environment and heritage) through international cooperation on fire research. The award recognises excellence in an IAFSS symposium paper in the field of fire safety science by a student making a significant contribution to that paper.

The winners will be selected by the IAFSS Awards Committee from papers accepted for presentation at the 10th IAFSS Symposium. A list of student papers will be provided to the Awards Committee by the Symposium Program Committee. The Award Committee may decide at its discretion not to select winners in all areas, increasing the amount of the awards available in the remaining areas. The Awards Committee will judge the papers on their quality; i.e., on the originality, clarity, and potential impact on practical or theoretical applications of fire safety science. Consideration may also be given to students who would not be able to attend the Symposium without additional support, and who will travel to attend the Symposium from remote regions.

The winners of the FORUM Student Travel Awards will be announced approximately a month after the authors receive notification of acceptance of their papers for presentation at the Symposium. The recipients will be honoured at a ceremony held during the 10th IAFSS Symposium in June 2011, with the Awards formally presented at that time.

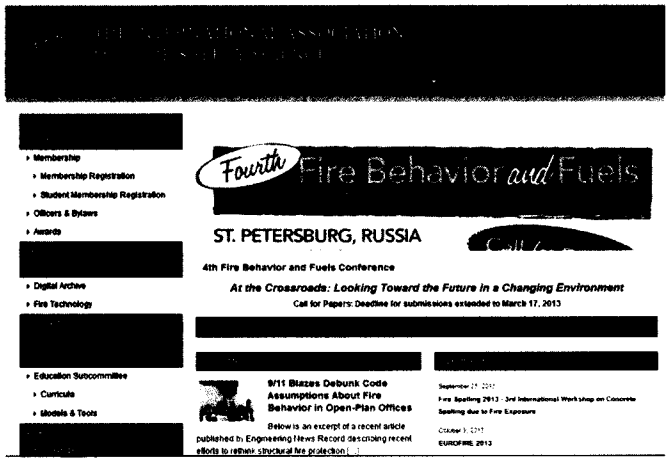
Selection body

The recipient of the Award will be selected by the IAFSS Awards Committee that consists of Professor Bogdan Dlugogorski (Chair, The University of Newcastle, Australia), Professor W.K. Chow (The Hong Kong Polytechnic University, HK, China), Professor Jim Quintiere (The University of Maryland, USA), Professor Takeyoshi Tanaka (Kyoto University, Japan) and Professor José Torero (The University of Edinburgh, Scotland, UK).

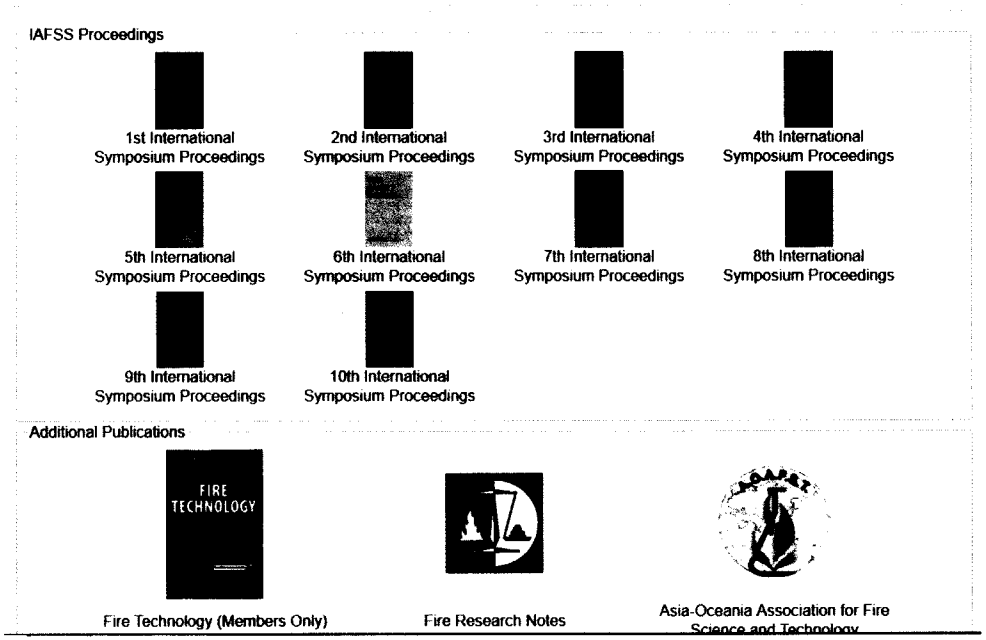
Rejuvenated IAFSS Website

Features:

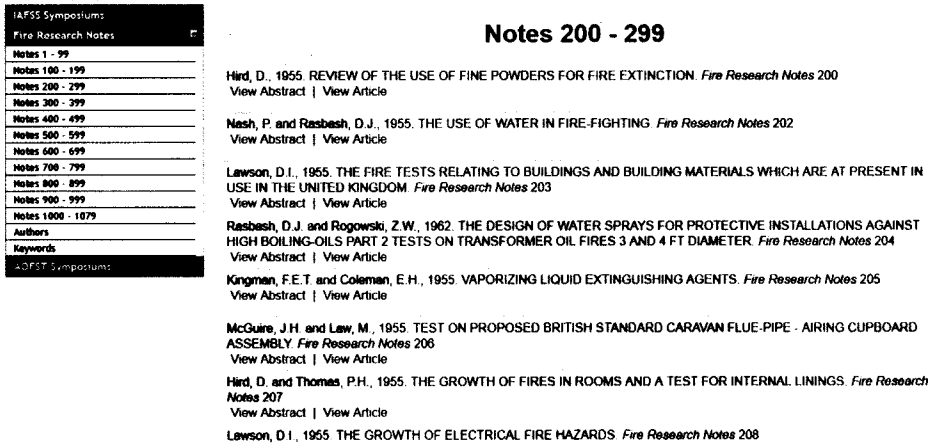
- Recent news
- Upcoming events
- Membership
- Registration
- Open Positions
- Digital Archive
- Newsletter
- Committees



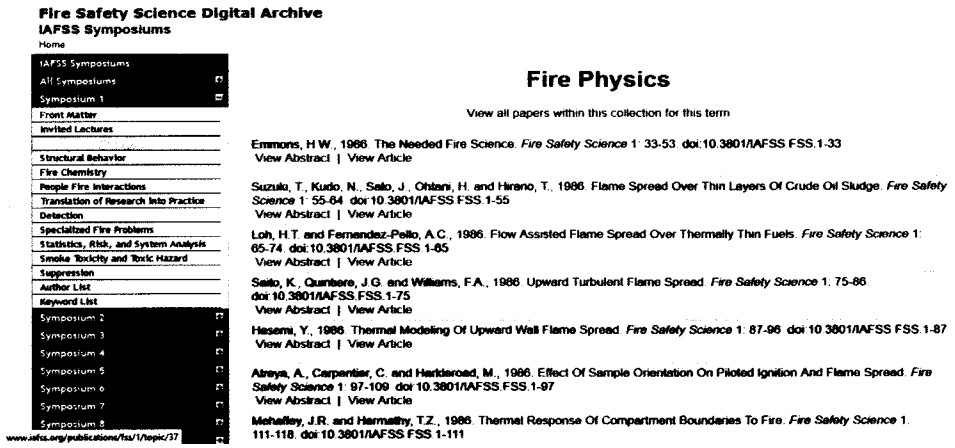
Digital Archive



Digital Archive: Fire Research Notes



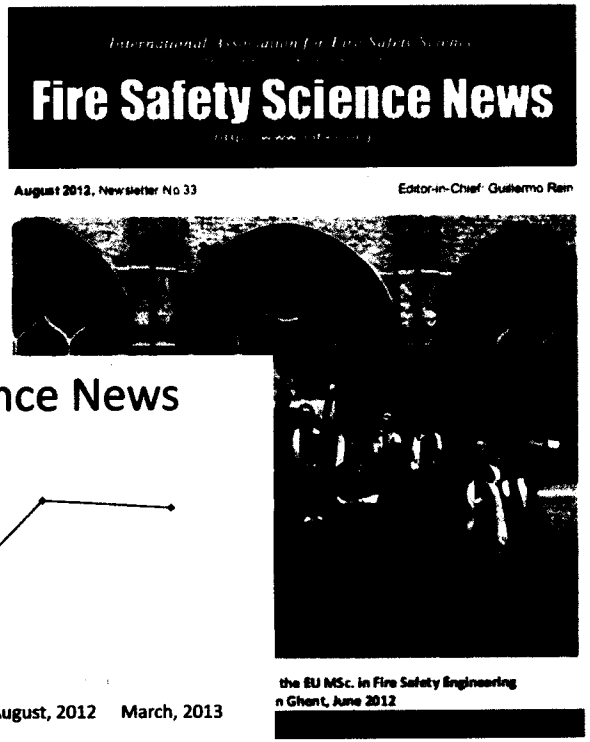
Digital Archive: Symposium Papers



Publication Statistics

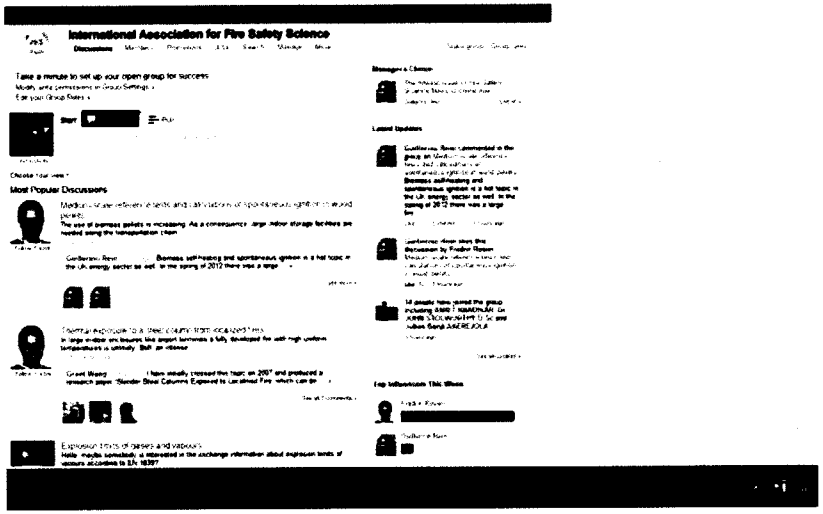
June 2012 – June 2013

- 17,000 paper views
- 2,000 user-clicked paper downloads
- Digital archive has increased IAFSS paper access

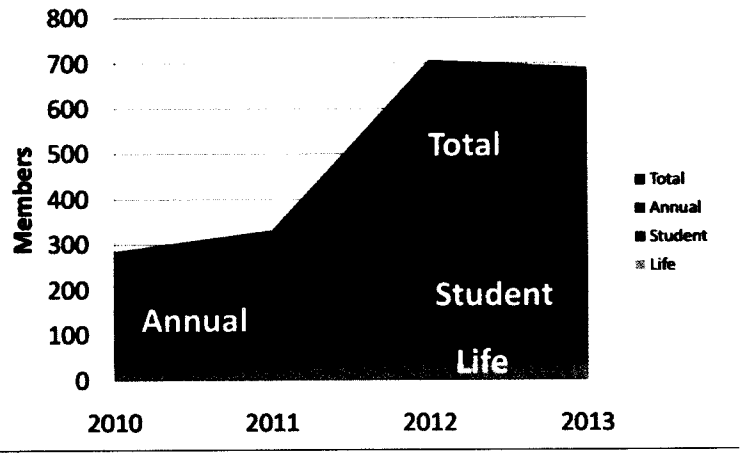


LinkedIn Group

- Started July 2011
- Total Members: 608



IAFSS Membership Statistics



Why not become a member?

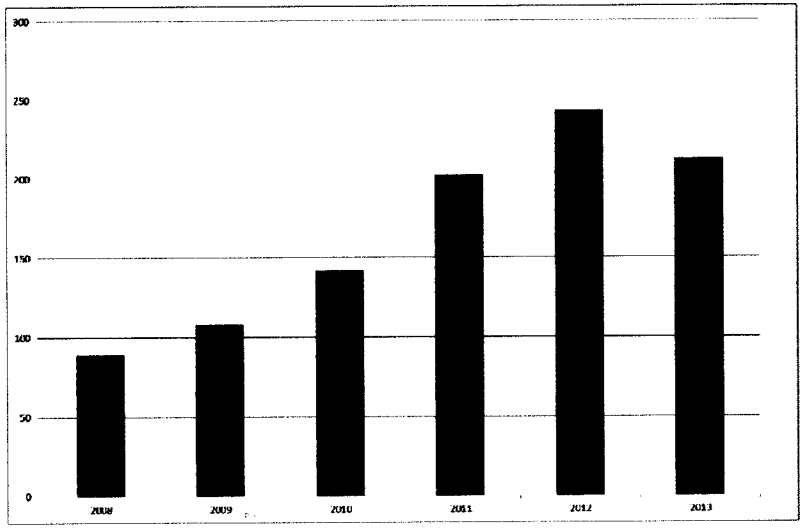
- **Symposia attendance at special member rates**
- Discounted Annual Subscription Fees to **Fire Safety Journal**
- Free Access to Springer's *Fire Technology*
- Newsletters
- Membership list with contact details
- A vote in association affairs
- Discounted Symposium Proceedings
- Support an international non-profit fire science organization!

Report on Fire Safety Journal
September 2013

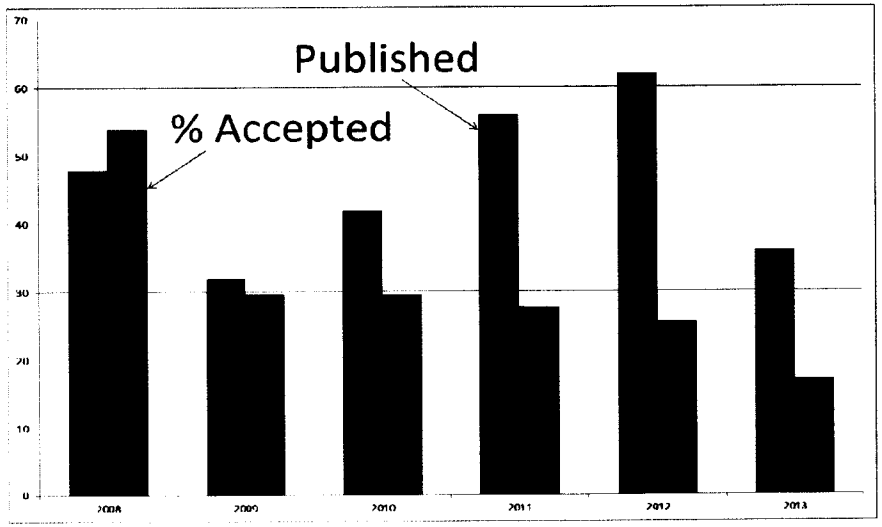
FIRE SAFETY JOURNAL

Jose L. Torero
Editor-in-Chief

Submissions



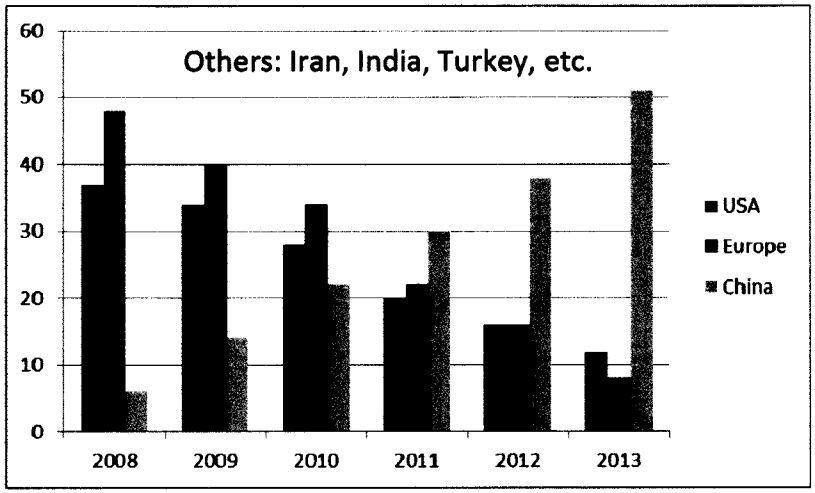
Published Papers



Special Issues

- Forest fires
- Large Outdoor Fires
- Experiments in fire
- Car Park Project in Ghent
- PRISM – Nuclear fire safety
- Urban Fire Management - GIS
- 1 Review paper on the behaviour of Masonry in Fire

Demographics



Acceptance

- USA>60%
- Europe>60%
- China<10%

Editorial Board

- Andre Marshall (University of Maryland) had to step down for personal reasons
- Replaced by Prof. Naian Liu (USTC - China)
  - Prof. Torero (Australia)
  - Prof. Dlugogorski (Australia)
  - Dr. Spearpoint (New Zealand)
  - Prof. Bailey (UK)
  - Prof. Merci (Belgium)
  - Dr. Simeoni (UK)
  - Dr. Carvel (UK)
- With the move of Dr. Simeoni and the loss of Prof. Marshall we have been left with an in-balance- No USA representation.

Other Indicators/Issues

- Impact factor, citations, etc. all fine – oscillate as normal but trend is generally up
- Very poor review response, quality timeliness (87% reviewer invitations do not respond, of those who respond 52% never complete the review, of those who review 64% take more than 90 days, of those reviews collected 48% have to be discarded ...)
- Long delays for review
- Large number of ethical issues (plagiarism, double submissions, conflicts, etc.)
- etc.

IAFSS

- After 4 years still no agreement
  - I have not been able to put together the promised Editorial Advisory Board
  - I have not been able to implement the promised succession plan

附錄四 火災與木質產品討論會（**Workshop on Fire and Wooden Product**）簡報資料(英文)

- Marc Janssens / Workshop Introduction
- ABRI / Alec M Y Lei
- VTT
- NIST
- CSTB
- SP
- FPRF
- FM Gobal
- NRCC
- SWRI
- FPI

FORUM Meeting, Paris, France, September 17-20, 2013

Workshop on Wood Construction and Fire

Marc Janssens, Ph.D., FSFPE
Southwest Research Institute
San Antonio, TX

WOOD AS A SUSTAINABLE MATERIAL
Introduction

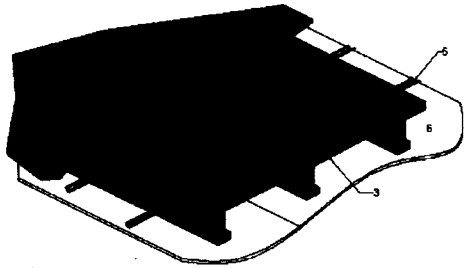
- Wood is a renewable resource when produced by sustainable forestry techniques
- Wood has significant advantages over other construction materials in terms of the environmental impact of its use
- This has been demonstrated by recent LCA studies conducted in different parts of the world
  - Lippke, B., Wilson, J., Perez-Garcia, J., Bowyer, J., and Meil, J., Forest Products Journal, 54, 8-19, 2004
  - John, S., Nebel, N., Perez, N., and Buchanan, A., Research Report 2008-02, University of Canterbury, Christchurch, 2009

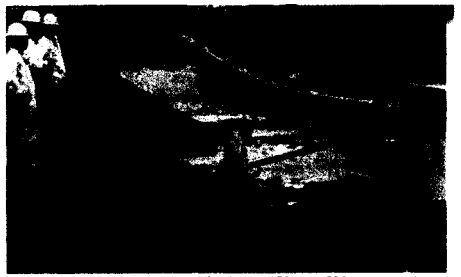
WOOD AS A SUSTAINABLE MATERIAL
New Zealand Study

- Modeled performance of 4 designs of a 6-story 4,200 m^2 office building—concrete, steel and 2 variations of wood
- Showed that increasing the amount of wood decreases the initial embodied energy and GWP of materials and the total energy consumption and GWP over the lifetime
- The wood-frame building with increased use of wood in architectural features had the lowest environmental impact, while the steel building had the highest
- This building could be considered to be 'carbon-neutral' for at least the first 12 years of its operation

WOOD BUILDINGS CAN BE FIRE-SAFE

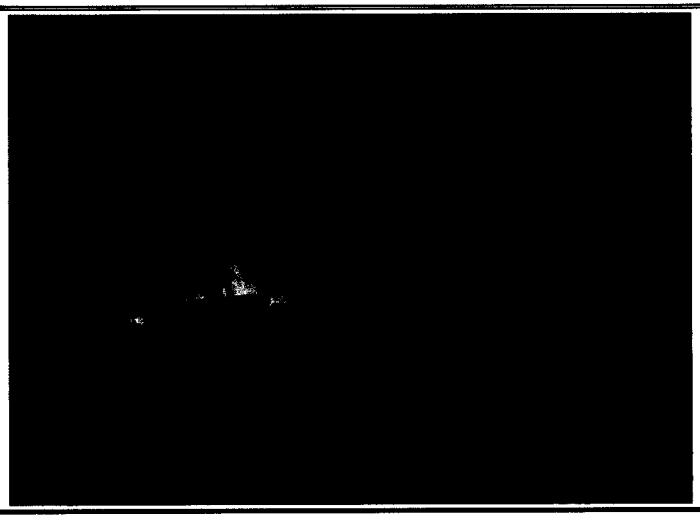
Protected Wood Members **Exposed Wood Members**





406mm, 60 kg/m steel beam (#W16x43) and 178mm x 533mm glulam beam following fire testing under full load. Steel beam collapsed after only 30 minutes of exposure while the glulam member remained straight and true, showing char formation on exposed surfaces.

... OR NOT



WORKSHOP PROGRAM

9.00 Workshop introduction – Marc Janssens, SwRI

9.10 Performance based background for revision of Finnish fire regulations concerning timber framed buildings – Tuula Hakkarainen, VTT

9.30 Fire and wood products research at NIST – Anthony Hamins, NIST

9.50 Fire behavior of connections, walls and floors – Dhionis Dhima, CSTB

10.10 Fire research on wood products in Sweden – Björn Sundström, SP

10.30 Coffee break

10.45 Fire safety challenges of tall wood buildings – Casey Grant, FPRF

11.05 Risk management considerations – Louis Gritzo, FM Global

11.25 Canada making strides in mid-rise wood buildings – Joseph Su, NRC

11.45 Research at FPInnovations – Christian Dagenais, FP Innovations

11.50 Workshop wrap-up – Marc Janssens, SwRI

Recent Development of Building Codes and Standards on Fire Safety of Wood Construction in Taiwan

ALEC M-Y LEI

Arch. & Bldg. Res. Inst., MOI, Chinese Taipei (ROC)

Outlines

- Green Building Policy and Wood Construction
- Brief Overview of Wood Construction History in Taiwan
- Regulatory Systems for Building Fire Safety
- Issues of Difficulty Encountered
- Progress in Promoting Wood Construction
- Concluding Remarks--Future Vision

Background

- ***Conventional Impressions***
  - ***The seismic resistance of RC or steel-constructed buildings, even brick-constructed, is better than timber-constructed***
  - ***In addition, wood is lack of fire resistance and easily decayed by fungi and insects***

Background

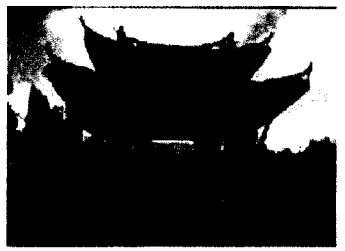
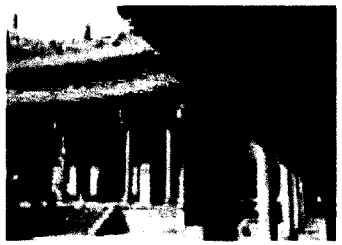
- ***wooden interior space provide an excellent indoors living environment ; "comfortable in summer and warm in winter"***
- ***People like wooden interior finish but not choose the wood-framed building. The ratio of WFB in all buildings is less than 2%.***

Green Building Policy and Wood Construction

- ***environmental protection & sustainability policy***
- ***wood construction -- the best choice of green building***
- ***governmental thrusters– ABRI & CPA***

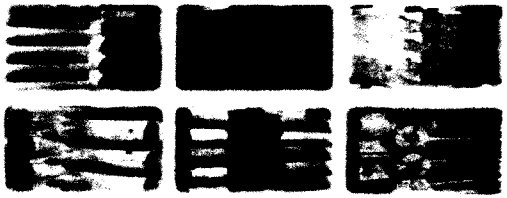
Brief Overview of Wood Construction History in Taiwan

~1945


Brief Overview of Wood Construction History in Taiwan

1988 ~ 1993



美國柱松(Lodgepole pine)
美西紅柏(Western Red Cedar)
花旗松、黃杉(Douglas Fir)

Brief Overview of Wood Construction History in Taiwan

1993 ~ 1997

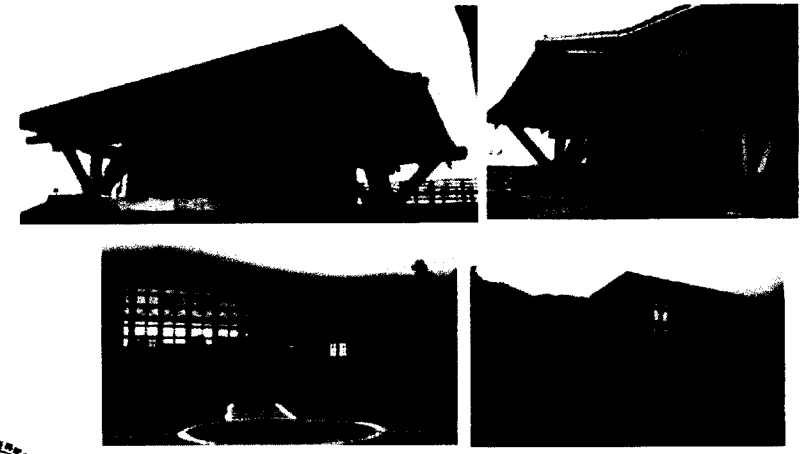



Brief Overview of Wood Construction History in Taiwan

since 1998

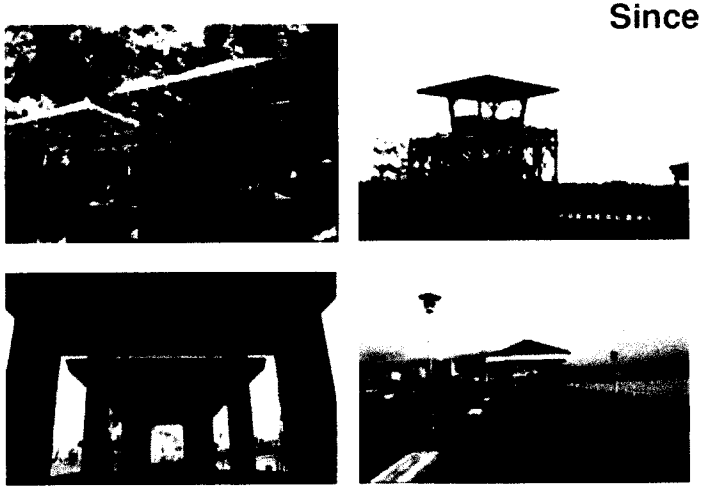
Brief Overview of Wood Construction History in Taiwan

Since 1998



Brief Overview of Wood Construction History in Taiwan

Since 1998



Regulatory Systems for Building Fire Safety

- *Building statutory provisions*
  - ***Building Law***
  - *Building Technical Regulation (BTR)*
- *Fire service statutory provisions*
  - ***Fire Service Law***
  - ***Fire Service Bylaw***
  - *Fire Service Equipment Regulations (FSER)*

Regulatory Systems for Building Fire Safety

- *Administration*
  - ***national level vs local level***
  - ***building control sector vs fire department***
- *Test methods*
  - ***Chinese National Standards (CNS)***
  - ***product standards & test standards***
  - ***fire performance test standards***

Issues of Difficulty Encountered

- ***Worried Issues about fire protection, earthquake resistance, typhoon resistance***
- ***Worried Issues about construction life, durability and preservation***
- ***Higher cost for land and construction, lower investment***

Issues of Difficulty Encountered

- ***Limits on loan application and insurance***
- ***Insufficient professional personnel for design and construction***
- ***Limited technical ability of local wood industry***

Progress in Promoting Wood Construction

- ***Amendment of BTR relating to the WFB***
  - ***Deletion of requirement on non-combustible roof construction and coverings. (Chap.3: Article 64)***
  - ***Requirements on fire rating of WFB, if the construction elements are fire-rated. (Chap.3: Article 70)***

Progress in Promoting Wood Construction

- ***Amendment of BTR relating to the WFB***
  - ***Requirements on fire compartment of WFB, if the construction elements are fire-rated. (Chap.3: Article 79, 79-1, 79-2, 79-3, 79-4)***
  - ***Requirements on area compartment of WFB, if the construction elements are not fire-rated. (Chap.3: Article 81)***

Progress in Promoting Wood Construction

- ***Amendment of BTR relating to the WFB***
  - ***Requirements on fire compartment in attached building of WFB, if the construction elements are not fire-rated. (Chap.3: Article 84)***
  - ***Requirements on external wall and roofing of WFB, if the construction elements are not fire-rated.(Chap.3: Article 84-1)***

Progress in Promoting Wood Construction

- ***Revision of CNS Standard***
  - *CNS 11031 Structural glulam*
  - ***CNS 11032 Overlaid glulam structural posts***
  - *CNS 12415 Method of fire resistance test for structural parts of building*
  - ***CNS 14631 Structural swan lumber used in platform construction***
  - ***CNS 14632 Finger joined structural swan lumber used in platform construction***
  - ***CNS 14646 Structural laminated veneer lumber***
  - ***CNS 14647 Structural wood-based panels***

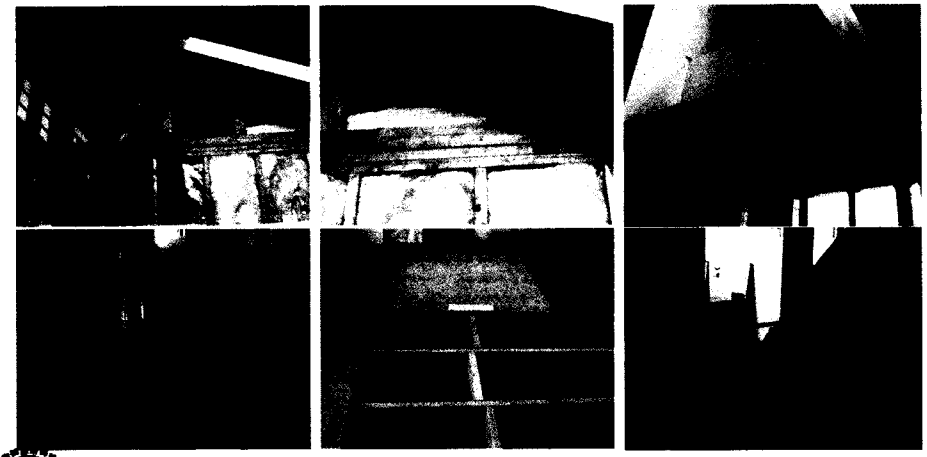
Progress in Promoting Wood Construction

- ***ABRI's R&D of Design Codes for Wood Construction***
  - ***Revise on the Technical Code for Design and Construction of Wood-Frame Building, 2001***
    - ***Drafted and reviewed by ABRI***
    - ***Approved and Issued by CPA(central building authority)***

Progress in Promoting Wood Construction

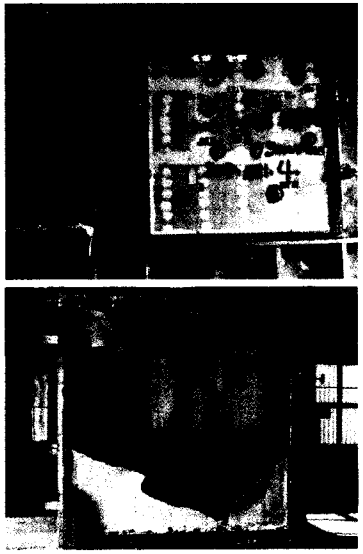
- *Study on the design and test of the fire resistant performance of wood-frame building, 2004*
  - *testing wood-frame partition assemblies for verifying the design manners used in northern American*
  - *Cooperated with COFI and Fornitek, Canadian wood associations and Canadian Trade & Culture Office in Taiwan, CTCO*

Light-Weight Wood-Frame Building



Revision of Technical Code

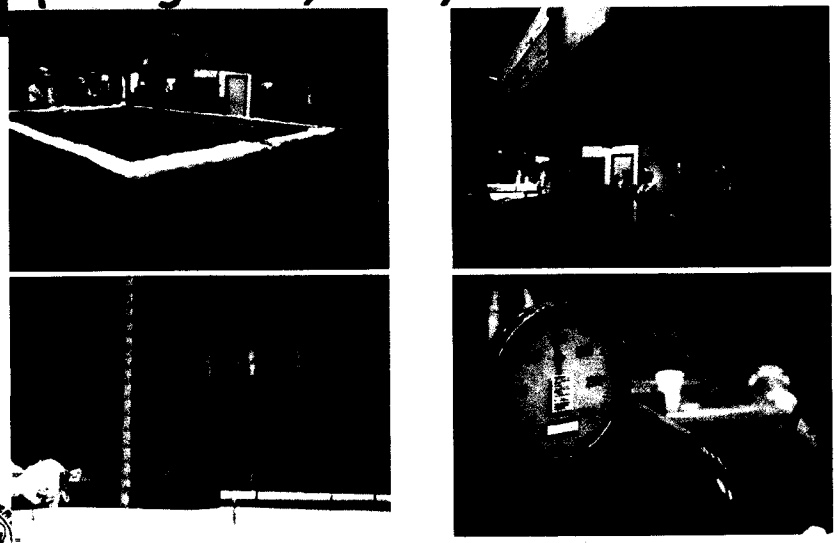
- *For LWFWB*
  - *Prescriptive provision – (1 hr rating)double ply of Grade 1 gypsum board (at least 15 mm thick) or calcium silicate board (at least 12mm thick) and insulation material of minimum density of 60 kg/m^3 (at least 50mm thick)*



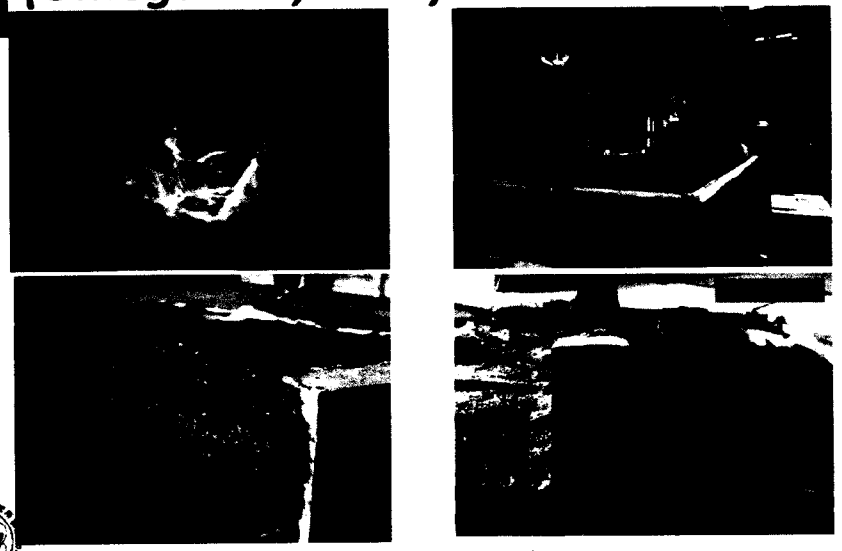
Progress in Promoting Wood Construction

- *Studies of technical codes for fire protection of timber construction and charring characteristics of glulam (2005-2006)*
  - *testing glulam beam for verifying the design manners used in northern American*
  - *Cooperated with APA, American engineering wood association and American Institute in Taiwan, AIT*

Glulam Beam Fire Testing (Omega Lab, 2005)



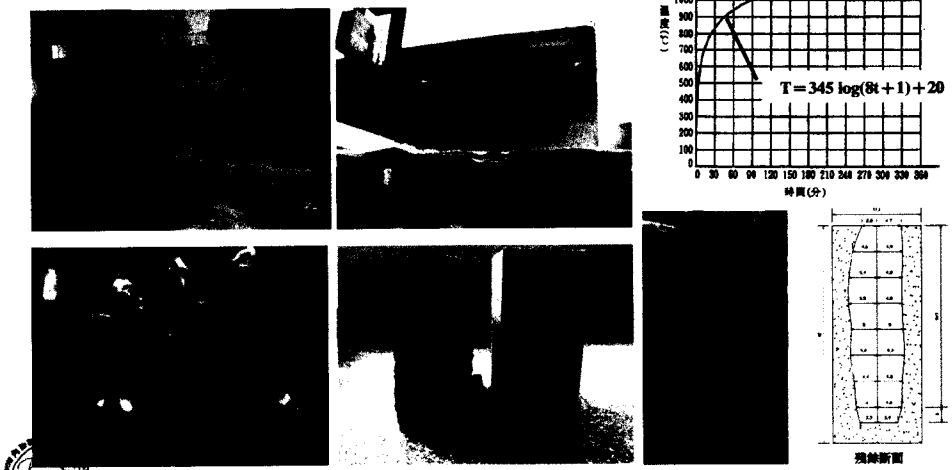
Glulam Beam Fire Testing (Omega Lab, 2005)



Progress in Promoting Wood Construction

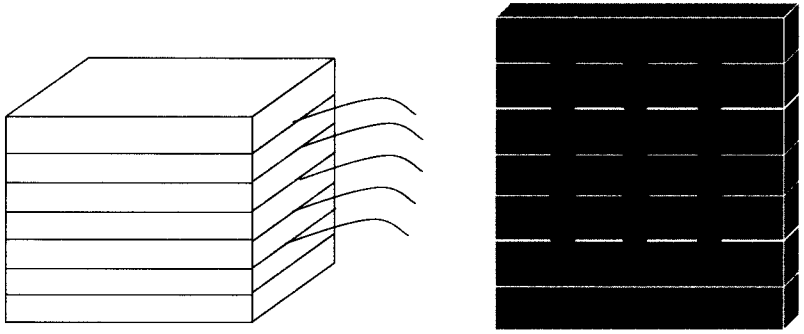
- ***Studies of technical codes for fire protection of timber construction and charring characteristics of glulam (2005-2006)***
  - ***to accomplish the "Chapter 9: Fire Protection" or to propose an individual draft on fire protection of WFB***
  - ***to verify the design methods of glulam structural members by means of fire testing***

Glulam Beam Fire Testing (ABRI Lab, 2006)



Charring Rate of Glulam of Different Wood Species

Results based on CNS 12514



Locations of T/Cs (temperature measurement)

Species	No.	Density (kg/m³)	time (min)	Side charring depth (cm)	Side charring rate (mm/min)	Base charring depth (cm)	Base charring rate (mm/min)
[redacted]							
	[redacted]						
Japanese cedar							
	SFT30	406	30	2.27	(0.26)	0.756	2.35	(0.22)	0.783
	SFT45	427	45	3.69	(0.33)	0.668	3.60	(0.31)	0.801
Taiwania fir	SFT30	429	30	1.97	(0.24)	0.655	2.60	(0.20)	0.865
	SFT45	437	45	2.74	(0.21)	0.608	2.77	(0.26)	0.614
	SFT60	466	60	4.54	(0.54)	0.757	4.90	(0.35)	0.817
[redacted]							
	[redacted]						
Southern pine							

Minimum Char Depth for Various Woods

表9.3-1 不同材種集成材燃燒實驗炭化深度

材種		實驗時間	側邊炭化深度	底部炭化深度	備註
集成材	杉木	30分鐘	20.0 mm	23.5 mm	1. 實驗方法採CNS12514「建築物構造部份之耐火試驗法」。 2. 試體三面受火。 3. 30分鐘實驗：試體斷面尺寸260 mm x 140 mm 4. 60分鐘實驗：試體斷面尺寸260 mm x 203 mm
		60分鐘	43.4 mm	46.0 mm	
	柳杉	30分鐘	20.4 mm	21.5 mm	
		60分鐘	42.1 mm	46.8 mm	
	台灣杉	30分鐘	22.7 mm	23.5 mm	
		60分鐘	45.4 mm	49.0 mm	
	花旗松	30分鐘	19.2 mm	20.8 mm	
		60分鐘	37.4 mm	37.9 mm	
	南方松	30分鐘	17.0 mm	17.2 mm	
		60分鐘	32.8 mm	34.0 mm	
	其他材種	30分鐘	25mm		
		60分鐘	50mm		
非集成材		30分鐘	30mm		
		60分鐘	60mm		

China fir

Japanese cedar

Taiwania fir

Douglas fir

Southern pine

Progress in Promoting Wood Construction

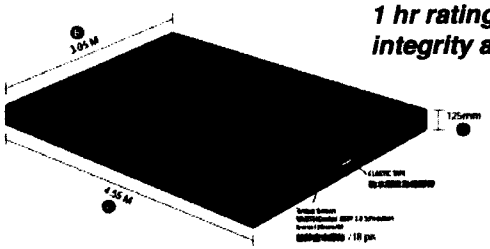
- *On October 2008, CPA published the amended part of Technical Code, Chapter 9: Fire Protection*
- *In 2011, ABRI Project on "Manual of Fire Safety Design and Construction of Wooden Building" was conducted to provide the detailed illustration.*
- *In 2012-2013, Manual Draft was reviewed by Task Group for publication.*

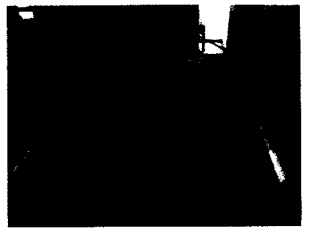
Concluding Remarks--Future Vision

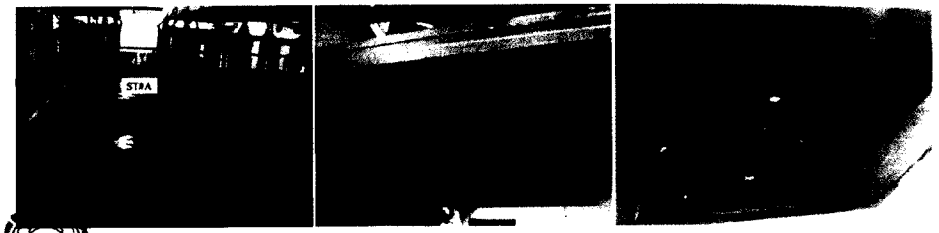
- ***Road Map***
  - ***Governmental Efforts***
  - ***Non-governmental Efforts***
  - ***International Collaboration***

CTL Floor Load-bearing Fire Testing

1 hr rating, load-bearing, integrity and insulation

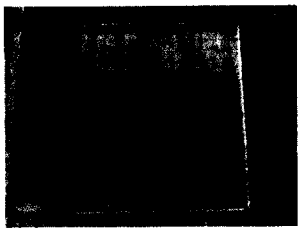


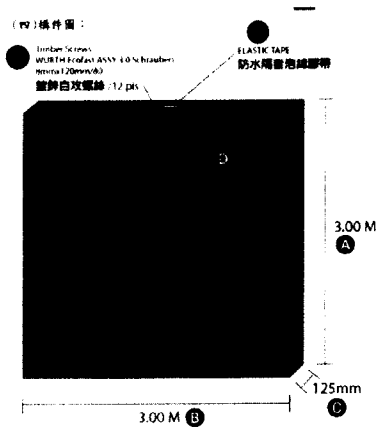


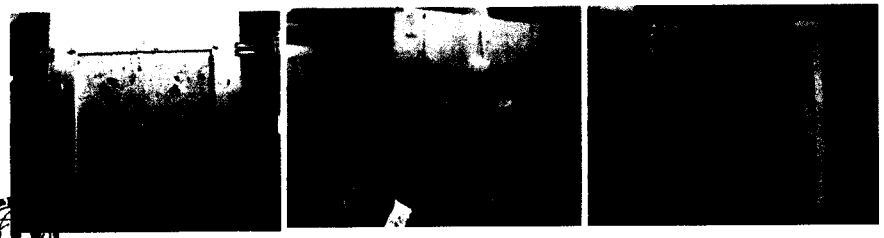


CTL Wall Load-bearing Fire Testing

1 hr rating, load-bearing, integrity and insulation







Thanks for your attention

Q & A

Business from technology

Performance based background for revision of Finnish fire regulations concerning timber framed buildings

FORUM workshop on fire and wood products
Tuula Hakkarainen
VTT Technical Research Centre of Finland

Based on the presentation by Dr Esko Mikkola in Wood & Fire Safety Conference 2012, Strbske Pleso, Slovakia

Background - Fire safety requirements in Finland

The National Building Code of Finland,
Part E1: Fire safety of buildings – Regulations and guidelines

The following topics are regulated:

- Constructions:
  - load bearing capacity
  - fire-separating building elements
- Internal and external surfaces
- Roof coverings
- Prevention of fire spread to neighbouring buildings:
  - fire walls
  - minimum distance between buildings
- Evacuation in case of fire
- Extinguishing and rescue

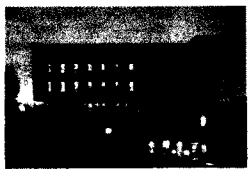
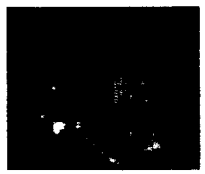
Wooden multi-storey buildings in Finland: apartment houses

- The first wooden multi-storey apartment houses were built in 1996 in Ylöjärvi house fair area: three wooden apartment houses of 2–3 storeys.
- At present, 13 wooden multi-storey apartment house projects have been completed. They include 37 houses (up to 5 storeys) with 647 apartments in total.
- About 30 projects are under planning or construction (up to 8 storeys).


Wooden multi-storey buildings in Finland: office buildings

Three wooden multi-storey office buildings completed:

- Metla building, Joensuu, 2004
  - 3 storeys; offices and laboratories for the Finnish Forest Research Institute
- Finnforest Modular Office, Espoo, 2005
  - 4 storeys; offices for a forest product company
- Pilke, Rovaniemi, 2010
  - 4 storeys; offices and exhibition spaces for the Finnish Forest and Park Service

Background for the latest regulations

- Earlier, the limit for timber framed structures was max. four storeys with sprinklers (two without sprinklers) and fire resistance R60 (3–4 storeys).
- A research study was made to define proposals for new fire requirements.
  - Fire safety engineering was used to justify different protective methods for timber structures.
  - The study was planned to include data on real fire loads and fires as well as comparisons with statistical data.
  - Comparison techniques were used: the requirements for max. 8-storey building with non-combustible (A2) load bearing structures as a reference.
    - Structures should withstand assumed fires (fire loads) with the same level of probability.
    - No fire brigade intervention considered, representing fire protection based only on passive means or automatic extinguishing.

Main principles

The study used measured fire load density and opening factor distributions of real apartment buildings as input data when parametric fire exposure levels were estimated in terms of standard fire exposures.

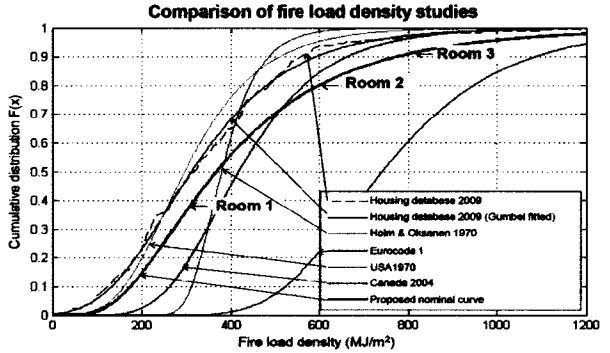
The different steps of the analysis are described below:

- **Input data** - fire load density and opening factor distributions, effectiveness of sprinklers
  - **Parametric temperature-time curves** + ventilation factors
    - **Equivalent times of fire exposure** for protected or non-protected load bearing structures
      - **Proportion of cases exceeding critical fire exposure** for timber structures and reference
        - **Required protection levels** for protective coverings and sprinklers

Fire load densities

- In the Finnish fire regulations it is assumed that fire load in residential buildings is not more than 600 MJ/m^2 of floor area.
- To combine this assumption with measured fire loads, the fire load distribution was defined to have 80 % fractile at 600 MJ/m^2.
- This is the 'Proposed nominal curve' in the next Figure. It was used in the analysis as the assumed fire load distribution.
  - This distribution slightly overestimates the recently measured fire load distribution in residential multi-storey buildings in Finland (Housing database 2009).

Comparison of fire load density studies



	Type of room	Fire load (MJ/m^2)	Opening factor (m$^{1/2}$)	Ventilation factor
Room 1	Living room	310	0.031	1.30
Room 2	Living room	607	0.054	0.989
Room 3	Bedroom	818	0.076	0.728

Opening and ventilation factors for room fires

Opening factor with the following limits $0.02 \leq O \leq 0.20$ ($m^{1/2}$):

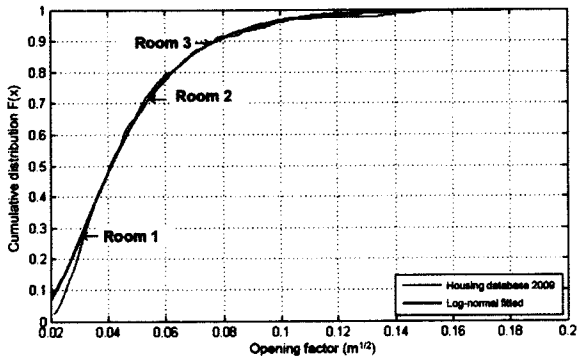
$$O = \frac{A_v \sqrt{h_{eq}}}{A_t}$$

where
A_v is total area of vertical openings on all walls
h_{eq} is weighted average of window heights on all walls
A_t is total area of enclosure (walls, ceiling and floor, including openings)

Ventilation factor for small fire compartments ($A_f < 100$ m^2) without openings in the roof:

$$wf = \frac{1}{\sqrt{O}} \frac{A_f}{A_t}$$

where
A_f is floor area of the fire compartment
O is opening factor
A_t is total area of enclosure (walls, ceiling and floor, including openings)



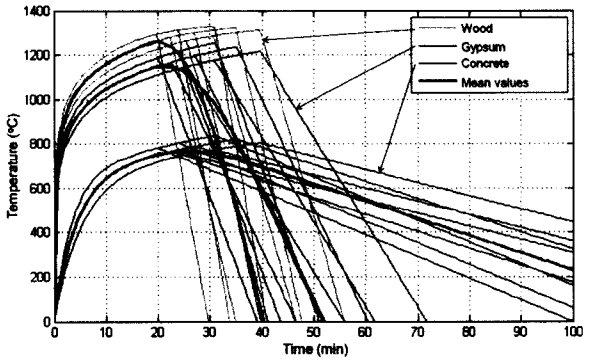
Protection of timber structures

- A basic principle (in Finnish fire regulations) is that the load-bearing structures of more than two-storey buildings shall not normally collapse during a fire even when no fire brigade intervention is assumed.
  - Thus, load-bearing timber structures need be protected from ignition/charring for the whole period of fire (including decay phase).
- One possible protection method is the covering classes K (fire protection ability) defined in the European fire classification (EN 13501-2 / EN 14135)
  - The principle is to define the time which the covering can protect the substrate (particle board for K_2) from ignition/charring (temperature increase not more than 250 °C in average and not more than 270 °C at maximum) under the standard fire conditions (ISO 834).
  - As a classification e.g. K_2 30 means 30 min protection time
- In Eurocode 5 (EN 1995-1-2) calculation method (also using ISO 834 exposure) the position of the char-line is taken as the position of the 300-degree isotherm (= close to the K classes criteria).

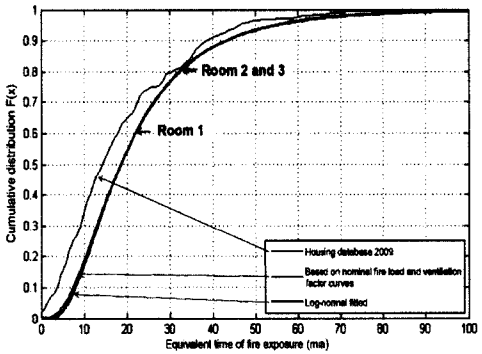
Fire exposure of parametric and standard fire curves

- The total exposure of a parametric fire curve (including cooling phase) was estimated in terms of standard fire curve exposure using the Eurocode 1 (EN 1991-1-2) formula of equivalent time of fire exposure.
  - It is noted that this method is not applicable for timber structures. It is also partly non-conservative for steel structures and to some extent for concrete structures.
  - However, in this study the method was used to transform parametric fire exposures to standard fire curve exposures to see the needs of fire protection (K class levels)
  - Both timber and steel structures can be protected using e.g. gypsum boards or wood panelling.
  - There is also a safety margin in these assumptions:
    - Timber structures do not immediately fail when the surface of the load-bearing structure have reached the 250 °C increase.
    - Similarly, there is a safety margin for steel structures.

Parametric temperature-time curves with wood, gypsum and concrete structures/linings



Equivalent time of fire exposure distribution (example)



If the protective covering fails at 60 min then about 3 % of the possible fires may lead to a situation where the timber structure starts burning and may lead to failure.

If the covering fails at 30 min then almost 25 % cases may lead to potential failure.

Equivalent time of fire exposure

$t_{e,d} = q_{f,d} \cdot k_b \cdot w_f$

where

$q_{f,d}$ is design fire load density

k_b is conversion factor (depends on the thermal properties of the enclosure; 0.07 is used for wood and gypsum boards and 0.055 for concrete)

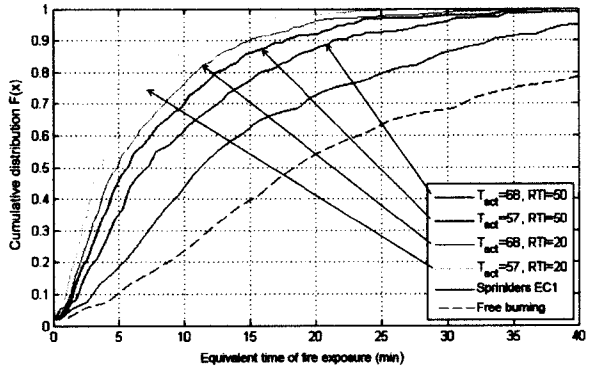
w_f is ventilation factor

- Equivalent time of fire exposure distributions were calculated using the fire load density distributions.
- In this study, analysis was made also with the assumption that the area of windows is 10 % of floor area which is the minimum requirement in the Finnish regulations (this leads to more severe conditions).

Effect of sprinklers

- In addition to the simplified Eurocode 1 reduction method for sprinklers (61 % of fire load taken into account), effectiveness of sprinklers was estimated in a more realistic way:
  - Four different sprinklers were used in the analysis
    - Activation temperatures (T_{act}) 57 and 68°C
    - Response time index (RTI) 50 and 20 $m^{1/2}s^{1/2}$
    - Water densities were assumed to be 5 mm/min
- Compared to the Eurocode 1 fire load reduction method, the main difference in this analysis was that the gas temperatures stay lower because of the controlling effect of fire by the sprinklers (this is well known from experiments).

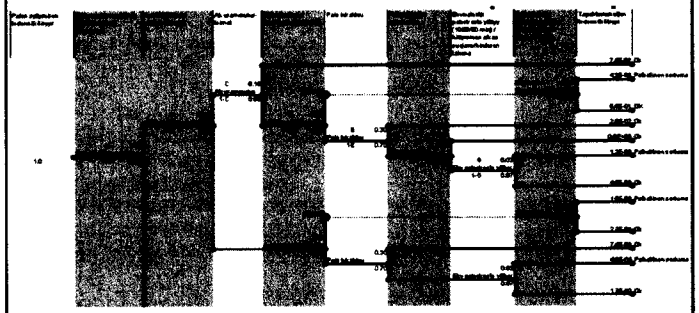
Effect of sprinklers for equivalent time of fire exposure



Event tree analysis

- An event tree analysis was used to make the fire protection using automatic extinguishing comparable with passive protection.
- Probabilities of the branches in the event tree were analysed to get the total probabilities for conditions having potential to local collapse:
  - A. A fire detector detects the fire and gives an alarm
  - B. Fire is detected by people
  - C. First-aid extinguishing is successful
  - D. Automatic water extinguishing system works; reliability of the system is assumed to be between 0.90 and 0.97
  - E. Fire is self-extinguished and does not reach the temperatures of parametric fire curves
  - F. Extinguishing by fire brigade; this was assumed to be 0.00
  - G. Equivalent time of fire exposure (10 min / 30 min / 60 min) is exceeded; charring of timber structures starts.
  - H. Charring starts in spite of sprinklers.

A part of the event tree



Relative probabilities of local collapse

- Relative probabilities for local collapse (= conditions which may lead to failure) per ignition in a compartment fire for protected timber structures and the reference structures were calculated.
- The protection alternatives included K_2 10, K_2 30 and K_2 60 coverings with and without sprinklers.
- In addition to the 8-storey reference buildings with steel or concrete load bearing structures, also max. 4-storey timber framed building with sprinklers was used as a reference.
  - This reference level is the fire class for timber framed buildings of 3–4 storeys in the Finnish requirements established in 1997.
- According to the next Table, failure probabilities for steel structures are clearly higher than for concrete structures.
  - Thus, the steel framed building will serve as an acceptance level for 5–8-storey buildings.

Relative probability of local collapse for different building types and protection methods

Building type, structures/materials and protection				Probability of local collapse			
Number of storeys	Structure/ surface	Sprinklers	Covering	Nominal distribution		Window area 10 % of floor area	
				Room	Apartment	Room	Apartment
Max 8	Conc/Conc	No	0	0.004	0.022	0.021	0.047
5-8	Wood/Gyp	No	10 min				
5-8	Wood/Gyp	No	30 min				
5-8	Wood/Gyp	No	60 min				
5-8	Wood/Gyp	Yes	0				
5-8	Wood/Gyp	Yes	10 min				
5-8	Wood/Gyp	Yes	30 min				
5-8	Wood/Gyp	Yes	60 min	0.010	0.015	0.013	0.018
Max. 4-storey timber framed and sprinklered building as a reference (according to 1997 regulations)							
3-4	Wood/Gyp	No	10 min				
3-4	Wood/Gyp	No	30 min				
3-4	Wood/Gyp	No	60 min				

Comparisons to fire statistics

- In this comparison to statistics, absolute probabilities were estimated using ignition frequency statistics of building fires
- In this case, also the intervention of fire brigade was taken into account (0.99 probability to extinguish the fire was assumed).
- Comparison of the local collapse probabilities of reference structures made of concrete with fire statistics of multi-storey concrete buildings in Finland showed that the calculated estimates were quite close to the statistical values (next Table).

Estimated and reported structural failures in multi-storey buildings in Finland

Building type, structures/materials No sprinklers		Number of local failures per year			
Number of floors	Structure/surface	Apartment buildings		Office buildings	
		Highest estimate	Mean estimate	Highest estimate	Mean estimate
Max 8	Steel/Gypsum	2.4	1.2	0.2	0.1
Max 8	Concrete/Concrete	0.6	0.3	0.1	0.02
3 - 8	Concrete/Concrete	0.25		Statistics Finland 2006-2009	

Conclusions of the study

- The performance of protection methods of timber structures under room fire conditions was analysed using fire safety engineering methods.
- Comparisons were made to safety levels of present regulations and statistical data of real fires.
- As a result of the studies, both passive and active methods together with performance levels were proposed for acceptance criteria.

Regulatory actions

- After a hearing process, the Ministry of the Environment published the following requirements in the 2011 revision of fire regulations:
  - K_2 30 covering together with sprinklers for timber framed residential and office buildings with 5 – 8 floors
  - K_2 10 covering with sprinklers for buildings with 3 – 4 floors

Summary of new possibilities for wood

New fire regulations in force since 15.4.2011

- Wood in load-bearing structures
  - Up to 8 storeys (earlier 4 storeys) in residential and office buildings with sprinklers
- Wood in internal linings
  - Can be used also in wood framed buildings with sprinklers of SFS-EN 12845 (OH) - residential and office buildings
  - New possibilities in assembly, business and production premises
- Wood in external linings: residential and office buildings with non-combustible load-bearing structures
  - Up to 4 storeys without sprinklers and up to 8 storeys with sprinklers (excluding ground floor and proximity of exits)
- One additional storey with wooden frame and external linings can be built to buildings with non-combustible frame and max. 7 storeys.

Acknowledgements

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