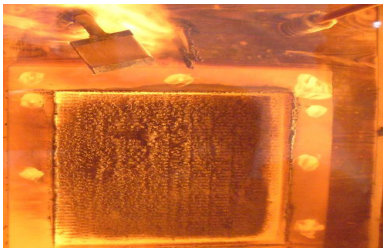
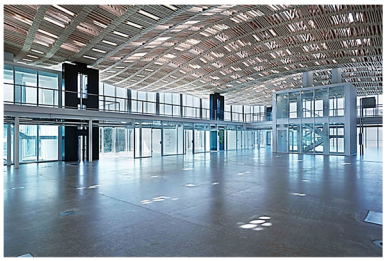
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Book of abstracts of the final conference COST FP 1404

”Fire Safe Use of Bio-Based Building Products”



Zürich, 1st and 2nd October 2018

Editors: Joachim Schmid, Massimo Fragiacomo

Organiser:	ETH Zürich, Switzerland
Chair of the Action:	Joachim Schmid
Vice Chair of the Action:	Massimo Fragiacomo

This publication is based upon work from COST Action FP 1404, supported by COST (European Cooperation in Science and Technology).

COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

www.cost.eu

Funded by the Horizon 2020 Framework Programme of the European Union

This book may be cited as:
Schmid, J., Fragiacomo, M., (eds) (2018)
Book of abstracts of the final conference COST FP 1404 “Fire Safe Use of Bio-Based Building Products”

ISBN: 978-3-906916-32-3

Online version, updates and corrections: http://www.costfp1404.ethz.ch/publications.html

Table of Contents

Chimneys' influence on fire risk of solid wooden structures in residential buildings in rural Balkan settlements

Ana Trombeva Gavriloska[1], Mirjana Laban[2], Meri Cvetkovska[3], Suzana Draganić[4]

[1] Cyril & Methodius University in Skopje, Faculty of Architecture, Bul. Partizanski odredi 24, 1000 Skopje, Macedonia, agavriloska@arh.ukim,edu.mk

[2] University of Novi Sad, Faculty of Technical Sciences, Department of Civil Engineering and Geodesy, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia, mlaban@uns.ac.rs

[3] Cyril & Methodius University in Skopje, Faculty of Civil Engineering, Bul. Partizanski odredi 24, 1000 Skopje, Macedonia, cvetkovska@gf.ukim,edu.mk

[4] University of Novi Sad, Faculty of Technical Sciences, Department of Civil Engineering and Geodesy, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia, suzanav@uns.ac.rs

Keywords: chimney fires, fire statistics, timber structures, residential buildings, risk analysis

The combustibility of wood is one of the main reasons why most building codes strictly limit the use of timber as building material, in particular, by limiting the number of storeys. In Macedonia, timber structures are limited to low-rise buildings with two storeys. The Serbian fire regulation codes were traditionally based on the prescriptive approach until 2009 when the new Fire Protection Law introduced performance based design and risk analysis. Although the codes allow it, performance based design is still not frequently in use for fire safety design of buildings in Serbia. The situation with the other Balkan and European countries is the same [1]. The number of storyes is not strictly limited by the fire safety codes, but buildings with a principal timber structure are generally constructed as low-rise buildings with maximum two storeys.

The official statistics of both Serbia and Macedonia shows that wooden houses account for about 1% of the total housing (residential homes) construction. Concrete, steel, brick (clay products) dominate in residential or public buildings. The situation in Montenegro is similar.

According to official Serbian fire statistics, chimney fires account for almost 20% of all fires that occur in family residential buildings every year in Serbia. Fire brigades classify the burning accumulated soot and tar inside the chimney as chimney fire. Fires in floor and roof structural elements occur due to damage of chimney walls, chimneys in contact with wooden girders or walls and other badly insulated or non-insulated wooden structural elements (Table 1), according to [2].

Table 1. Fire causes in Serbia in the period 2002-2013

Year*	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Structural defects	45	53	48	81	226	43	30	38	69	52	46	17	748
Fireplace malfunction	295	338	394	368	315	213	247	385	414	603	547	174	4293

** Data from 2002 to 2009 are based on preventive protection inspector's survey, while data from 2010 to 2013 are based on fire rescue units' intervention records*

Fire statistics database and analysis represent the basis for fire risk identification, analysis and assessment. Temporal analyses of timber structure fire incidents occurring in rural lowland settlements in Serbia (Žabalj and Žitište, from 2010 to 2014) are carried out. Statistic data on location of fire occurrence represent data registered by fire brigades in their fire reports, meaning that they are based on field experience, not experts' investigation and research. Fire inspectors and court officials are obliged to conduct the investigations and provide detailed reports for official legal use. These reports are not available for scientific research without a special legal approval, which is a very long and difficult procedure. The findings presented in this paper are therefore based on local fire brigades' reports.

The main objective of this study was to gather and analyse data on various causes of fires in order to determine the extent to which existing data can be used in fire risk assessment. This research illustrates how the patterns of timber structural fire incidents vary with the time of the day, the day of the week, and the month of the year. It is shown that significant differences exist in respect to fire causation over time and the types of heating systems in buildings.

Fire statistics on the history of fire occurrences (specific place/room, season, month, time of day) is valuable for fire risk assessment in terms of probability calculation. Spatiotemporal analysis of fire incidents could provide a useful information for planning of fire prevention and response activities in terms of risk identification, resource targeting and routing of fire personnel and equipment, allocation of preventative measures, and policy evaluation [3, 4].

To improve the risk analysis and assessment, it is also important to research the specific types of settlements (buildings, dwellings, inhabitants). The knowledge on the age and quality of dwellings or the type of installation and equipment, as well as the habits of the residents could be helpful in risk identification. Knowing the relations between the characteristics of the settlements and fire occurrences could also contribute to the creation of better fire prevention plans and measures. The preventive measures should include ones which would contribute to mitigation of social vulnerability of analysed settlements. The elderly and/or single households, with low incomes and limited access to distance heating system or piped gas, are not able to provide stoves of good quality or proper maintenance of their homes and chimneys. Additionally, there is always possibility that they use the lower quality coal and wood for heating, which contribute to faster forming of soot and tar layers in chimneys.

The most applied firefighting measure, according to information provided by Fire brigades, is to let the soot and tar to burn out under control of firefighters, if the fire hasn't spread to the attics or the roof structure.

The statistic on fires that occurred in two lowland settlements (municipalities of Žabalj and Žitište in Vojvodina, Serbia) was analysed. Žabalj and Žitište are typical lowland settlements in Vojvodina region in Serbia, with family housing and agriculture oriented economy.

The municipality of Žabalj has 26.134 residents who live in 7.354 dwellings, while the other 2.527 (35%) dwellings out of 9.881 registered in the 2011 Census are not permanently inhabited (these are temporarily unoccupied and abandoned). There are 6260 (85%) inhabited dwellings that are older than 25 years. Out of these, 444 (9%) are with outer walls made of weak material. Buildings made of weak material are those whose outer walls are built solely or predominantly of soil cement, adobe, wattle dam, boards, etc. In these buildings, the pitched roof structure and attic floor construction are predominantly made of wood.

The municipality of Žitište has 16.841 residents who live in 6.138 dwellings, while the other 164 (2,6%) out of 6302 dwellings registered in the 2011 Census are not permanently inhabited (these are temporarily unoccupied and abandoned). There are 5.382 (88%) inhabited dwellings older than 25 years. Out of these, 3.725 (39%) are with outer walls made of weak material, a wooden roof structure and an attic floor construction predominantly made of wood.

In both Žabalj and Žitište settlements, in the case of buildings made of a hard material (the outer walls are built solely or predominantly of brick, hollow clay block, gas concrete, and other contemporary construction materials and elements), the pitched roof structure is made of solid wood. These types of family houses are also predominant in city outskirts. Most of the buildings built before 1946 in the city downtown areas are also built with a pitched roof structure constructed of solid wood.

A preliminary analysis indicated that most of the fires started from the chimneys. These findings encouraged research of data on the type of heating installations available in Žabalj and Žitište. According to the 2011 census, only 8.7% of the dwellings in Serbia have the availability of piped gas for heating. However, the situation in Vojvodina region is better (28%), namely, piped gas is in use for heating in 39% of the dwellings in Žabalj and 51% of the dwellings in Žitište. There are also district or central heating installations in 33% of the dwellings in Žabalj and 16% of the dwellings in Žitište. There were 110 fire events in residential buildings registered by local fire-fighting brigades in Žabalj and Žitište municipalities in the period 2010 -2014. The results of the fire statistics indicate that most of the fires occurred in the winter season, in the course of the working days of the week and during nights (Fig. 1). Since the roof structures are predominantly made of wood and the fire in the chimneys may, in certain circumstances, easily spread to the roof, chimney fires increase the risk of fire in the attics or the roofs. In many cases, it only depends on the time of the fire brigade arrival whether the chimney fire will be spread further through the house.

The number of chimney fires represents almost half of the number of residential building fires that broke out in the researched rural areas (47.27%) in the analysed time period (Fig. 2). The share of roof fires is 10.91% of the total number of residential building fires. The records in the fire brigades'

fire reports show that most of the roof fires started near the chimneys. In terms of potential risk, based on the acquired data, this may indicate the possibility that 23.08% of the chimney fires will be spread to the wooden roof structures. Also, according to the available records, there is no fire alarm in any home in analysed area.

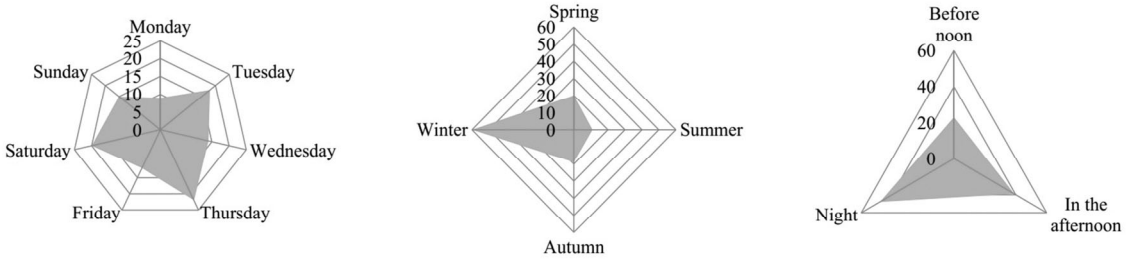


Figure 1. Daily, seasonally and period-of-the-day distribution of total fire incidents in Žabalj and Žitište municipalities, in the period 2010 - 2014.

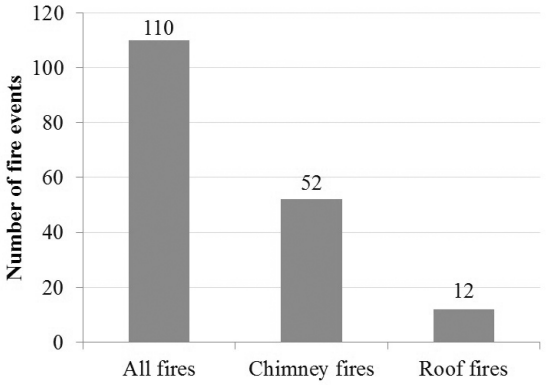


Figure 2. The share of chimney and roof fires in all fires and the share of chimney fires which were spread to the roof structures.

Having in mind that there are very limited possibilities for fire extinguishing in this type of households, an additional risk factor contributing to fire spreading is the distance to the fire brigade station. The travelling speed of the firefighting vehicles is 1 km per minute. It is an adopted parameter for the calculations in Serbia. There is no time limitation for the time of arrival to the fire accident. Both municipalities have one firefighting brigade each, located in Žabalj and Žitište and are more than 5 km away, which means that the fire has enough time to spread through the whole house, before the fire-fighters arrive.

Conclusion

Roof fires are the predominant type of fires analysed in residential family buildings in the Balkan rural settlements. Fires are most frequent in winter, during the heating season, in houses with no availability of district heating or piped gas. There is a large percentage of fires related to chimneys due to lack of maintenance. The fire starts, in most cases, in the chimneys (inflamed soot and tar layers) and spreads to the timber roof construction in the attic. The risk increases with the age of the house (cracks in the chimney walls) and lack of maintenance (chimneys are not controlled and cleaned regularly). Additional risk factors are the age of the inhabitants and the distance to a fire

brigade station. The combination of all these factors may cause extensive damage, injuries and even loss of life.

Although building regulations in all three Balkan countries prescribe regular maintenance of chimneys, those regulations address only multi-residential buildings, industrial facilities and business premises, and concern buildings with central heating systems using piped gas. Rural settlements, in both lowland and mountain area are still very vulnerable to chimney fires. Fire safety regulations do not prescribe any kind of advisory or regular control of households in rural settlements. The research presented in this paper proved the relevance of social vulnerability to fire risks, since the predominant population in rural settlements are elderly people living in old traditional houses, in single or two people households, and in many cases those are single old women, with no capability to maintain their homes. Rural settlements also have limited access to distance heating systems or piped gas. Even more, where those kinds of heating infrastructures are available, they cannot afford it due to low incomes.

Since the analysed fire risks originate primarily from social vulnerability, preventive fire risk measures should contribute to increasing the resilience of local rural communities to fire hazards. This can be achieved by building the capacities of local governments and voluntary fire departments, both in human resources and financially. Fire safety regulations should be improved and advisory fire safety control should be performed on regular basis in rural settlements with elderly and single households. Fire occurrence patterns indicate that the controls should be done in winter season, on working days. Regular chimney maintenance and control, as well as additional insulation of chimney, should be provided by local governments for vulnerable groups. Since most of the fires occur during the night, the most effective measure to prevent people's death under such circumstances is smoke alarm that would warn residents about the presence of noxious carbon monoxide fumes. It would also decrease the time needed for evacuation from the fire endangered area. During the summer, the number of fires in rural residential buildings is reduced in respect to the winter period, while the number of outdoor fires is increased due to the high ambient temperature and agricultural works. This is s also an issue that should be taken into consideration when planning the fire preventive measures in rural areas.

Acknowledgements

The paper was written in the framework of the COST Action FP1404 “COST Action FP1404 - Fire Safe Use of Bio-Based Building” (http://www.costfp1404.ethz.ch/).

References

[1] E. Mikkola, Comparison of National Fire Safety Requirements within COST Action FP1404, International Wood Products Journal, 2017, DOI: 10.1080/20426445.2016.1247130

[2] Data published at official website of Ministry of Internal Affairs of Republic of Serbia, http://arhiva.mup.gov.rs/cms_eng/home.nsf/index-eng.html# , (accessed 18.02.17).

[3] A.Asgary , A. Ghaffari, J. Levy: Spatial and Temporal Analyses of Structural Fire Incidents and Their Causes: A Case of Toronto, Canada, Fire Safety Journal 45, Volume 45, Issue 1 (2010) pp. 44–57, http://dx.doi.org/10.1016/j.firesaf.2009.10.002 .

[4] J. Corcoran,G. Higgs, C. Brunsdon, A. Ware, P. Norman, The Use of Spatial Analytical Techniques to Explore Patterns of Fire Incidence: a South Wales Case Study, Computers, Environments and Urban Systems 31, Volume 31, Issue 6 (2007) pp. 623–647, http://dx.doi.org/10.1016/j.compenvurbsys.2007.01.002.