Wood2New

Performance and maintenance of bio-based building materials influencing the life cycle and LCA
Kranjska Gora, Slovenia 23 – 24.10 2014

Using wood based interior materials to promote human well-being: project Wood2New

Yrsa Cronhjort[1], Karl Dobianer[2], Elisabeth Habla[3*], Mark Hughes[4], Katie Livesey[5], Tomas Nord[6], Anders Nyrud[7], Martin Weigl[8]

Project Wood2New, "Competitive wood based interior materials and systems for modern wood construction" is an international project started in 2014. Key topics include the securing of a good indoor environment, human health and psychological well-being, the potential for multi-functional wood-based products and systems, and the development of solutions combining material properties of wood with high-quality design. The results aim at applicability for market segments selected based on research of consumer preferences and the business environment of wood based products.

We spend 90% of our lives inside buildings and this affects our physical and psychological well-being and comfort. Comfort is most widely associated with temperature, humidity, noise, light and smell and these factors are addressed by various regulations. However, the significance of well-being, particularly psychological well-being inside buildings, is poorly understood. Increasing evidence shows that contact with nature is important for the overall well-being of the occupants of buildings. Studies have indicated that the occupants' response to natural materials such as wood is very positive with a strong preference shown for interior spaces containing high proportions of wood. Differences in wood ratios have also been shown to produce different physiological responses especially in autonomic nervous system activity.

The overarching aims for the development of our built environment and construction in general reflect the European 2020-targets and beyond, aiming at resource efficiency and significant reductions of, among others, carbon dioxide emissions and energy use. Wood is a renewable and sustainable resource when using raw material deriving from sustainably managed forests. As resources are becoming scarcer and the importance of a sustainable development increases, materials and products with environmentally, socially and economically sound values should have an advantage if they can deliver competitive performance. The competitiveness of wood based products and systems should be improved based on these values.

Materials should be chosen to be fit for purpose in terms of their location and their contribution to the risk of accidents. The safety implications of material selection are well documented with codes and regulations in place to ensure the safety of the public i.e. fire regulations, building regulations, and e.g. the Regulation (EU) No 305/2011 including requirements on hygiene, health and the environment, energy economy and heat retention, and the sustainable use of natural resources. Limitations for the use of wood in interiors need to be globally identified, including an overview of regulations, standards, and certifications.

Current knowledge on the health effects of wood-based emissions is sparse and inconsistent. A few studies have shown that wood-specific volatile organic compound (VOC) emissions could have positive vegetative effects, whilst others found no detrimental effect on human health, and in other cases they are claimed to be potentially harmful. The current project deals with long term emissions from wood in real life tests, coupled with toxicology, epidemiology and human perception.

Other properties that affect human perception of materials and surfaces include colour, surface structure and surface temperature. Work in the project Wood2New will continue through a look into factors that influence the haptic properties of wood surfaces as to find measurable parameters to characterise them and investigate the potential of latent heat exchange to reduce energy consumption. Additionally, the potential for increasing the use of wood in interiors and the effects thereof will be studied through research by design.

Wood2New aims at tangible results promoting economically and ecologically sound living spaces supporting human well-being.

Indoor Air Quality Holzforschung Austria

HOLZ FORSCHUNG AUSTRIA

Holzforschung Austria is involved in several work packages of Wood2New. One among them is the assessment of indoor air quality in timber prefabricated houses and its influence on the human health and well-being. 20 newly built houses shall be examined over a period of about 6 months during inhabitation. The first sampling will be conducted after insertion of the screed and before the move in, to capture the emissions derived from the building structure alone. After this initial measurement monthly analyses will provide information concerning the development of the indoor air quality in focus of changes due to furnishing, airing- out effects and user behaviour. To achieve comparability among the results, and because it is the room in which the most time of a day is spent, the sampling will be conducted in the bedroom of the building.

The following parameters will be examined during the sampling:

Emission of volatile organic compounds (VOC)

The World Health Organization[1] defined VOC as organic substances with a boiling point between 50 °C and 250 °C. A huge number of substances comply to this specification, among them several timber typical emissions such as alpha- pinene and delta- 3-carene. Usually the sum of all single substances with concentrations > 5 µg/m³ is used for the assessment of indoor air quality. The sampling is conducted according to ISO 16000-6[2], -9[3] an -11[4] with sampling pumps that draw a predefined volume of indoor air through Tenax TA® (polymer resin based on 2,6– diphenylene oxide) filled tubes. Qualitative and quantitative analysis is carried out with gas chromatography coupled with mass spectrometry (GC/MS).

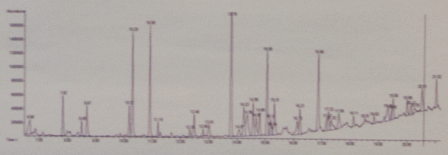

Figure 1: GC/MS chromatogram of a VOC measurement

Particle count

The amount of airborne particulate matter with a diameter of ≤ 10 µm (PM_{10}) is being compared between indoor and outdoor air. The measurements are conducted with a laser particle counter.

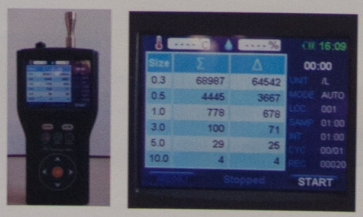

Figure 2: particle counter and example of indoor P

Formaldehyde and other carbonyl compounds

The concentration of formaldehyde and other carbonyl compounds in the indoor air is measured in accordance to ISO 16000-3[5] using 2,4-dinitrophenylhydrazine (DNPH) filled cartridges. Qualitative and quantitative analysis is carried out with high performance liquid chromatography coupled with a diode array detector (DAD).

Figure 3: **(a)** DNPH cartridges new (white) and loaded with carbonyls (yellow) **(b)** HPLC with DAD

Airborne microbes (colony- forming units, CFU)

The number of CFU in indoor air and outdoor air is determined by sampling of a predefined air volume on malt extract agar and dichloran glycerol (DG18) agar, cultivation and plate counting.

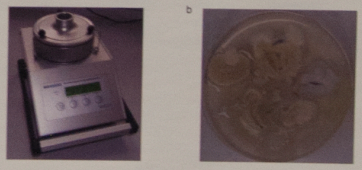

Figure 2: **(a)** air sampler for CFU determination **(b)** cultivated plate

Indoor climate data (relative Humidity, Temperature)

Since the above described indoor emissions correlate with ambient conditions the indoor climate is recorded.

Health and well-being of inhabitants

Blood pressure, pulse, lung volume and eyelid closure frequency will be examined as indicators for the inhabitants health. Additionally the inhabitants will receive standardized medical questionnaires concerning their overall well-being and health at every sampling date. The obtained data will be epidemiological assessed. The toxicological assessment, especially of the emission levels of VOC, formaldehyde and other carbonyl compounds, will be carried out within the project consortium.

[1] World Health Organization, WHO (1989) – Indoor Air Quality: Organic Pollutants. Euro reports and Studies, 11. Copenhagen, Regional Office for Europe.

[2] DIN ISO 16000-6 (2004): Indoor air - Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA® sorbent, thermal desorption and gas chromatography using MS/FID

[3] ÖNORM EN ISO 16000-9 (2006): Indoor air - Part 9: Determination of the emission of volatile organic compounds from building products and furnishing - Emission test chamber

[4] ÖNORM EN ISO 16000-11 (2006): Indoor air - Part 11: Determination of the emission of volatile organic compounds from building products and furnishing - Sampling, storage of samples and preparation of test specimens

[5] DIN EN ISO 16000-3 (2011): Indoor air - Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air – active sampling method

[1] Finland, Aalto University, yrsa.cronhjort@aalto.fi, coordinator
[2] Austria, Technisches Büro für Chemie, Dr. Karl Dobianer office@dobianer.com
[3*] Austria, Holzforschung Austria, e.habla@holzforschung.at, presenting author
[4] Finland, Aalto University, mark.hughes@aalto.fi
[5] United Kingdom, Building Research Establishment Ltd, liveseyk@bre.co.uk
[6] Sweden, Linköping University, tomas.nord@liu.se
[7] Norway, Norsk TreTeknisk Institutt, anders.nyrud@treteknisk.no
[8] Austria, Holzforschung Austria, m.weigl@holzforschung.at

Acknowledgments: The research project has received funding from the WoodWisdom-Net Research Programme which is a transnational R&D programme jointly funded by national funding organisations within the framework of the ERA-NET Plus Action WoodWisdom-Net+.

www.wood2new.org