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Performance-Based Design methodology for the evaluation of WUI microscale fire hazards

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Abstract

Performance-Based Design (PBD) is an engineering approach to fire protection design based on agreed upon fire safety goals and objectives, analysis of fire scenarios, and quantitative assessment of design alternatives against the goals and objectives using accepted engineering methodologies and performance criteria (Society of Fire Protection Engineers, 2007). At the Wildland-Urban Interface (WUI), regulatory bodies, research institutions and practitioners are starting to address its fire safety challenges with the aid of PBD methods. In the USA, for example, the National Fire Protection Agency (NFPA) has recommended considering a design fire scenario of an outside fire exposure for PBD projects involving WUI structures (National Fire Protection Association, 2018). The complexity of the different interactions that can occur between fire, structures and residents can be analysed through a PBD approach for both new and existing buildings located at the WUI. The many variables and scenarios can be analysed with the help of Computational Fluid Dynamics (CFD) tools such as FDS (Fire Dynamics Simulator (NIST, 2020)). Despite the inherent and unavoidable uncertainty of CFD, this modelling approach allows for great flexibility in the definition of different configurations, materials and fire loads, which is otherwise very difficult to achieve in experimental tests or in prescribed regulations (Vacca et al., 2020). A specific WUI microscale (i.e. homeowner scale) PBD methodology has been developed within the WUIVIEW project, funded by the Directorate General for European Civil Protection and Humanitarian Aid Operations (DG ECHO). This methodology has been successfully applied to different dwellings posing mainly structure survivability objectives. A WUI PBD guideline has been subsequently created (Vacca and Planas, 2021), which follows the classic PBD steps that consist of: (i) the identification of the scope, goals and objectives of the project; (ii) the selection of the performance criteria as threshold values for the quantification of the hazard; (iii) the design of fire scenarios; (iv) the development of trial designs; (v) the evaluation of these designs. In this paper, we show the steps of the guideline by applying it to the real case study of a WUI property located in the region of Madrid (Spain). Suggestions on the selection of design fire scenarios are presented, along with the description of the needed

fire, environmental, and property/plot characteristics. Selected scenarios are modelled and analysed with FDS, and the obtained results, which highlight the property's weaknesses and vulnerabilities regarding residential fuels and structural elements, are shown.

Keywords: Wildland-Urban Interface, WUIVIEW project, fire safety engineering, residential fuels

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