Quantitative assessment framework of IAQ resilience in buildings

Douaa Al Assaad[1,2], Hilde Breesch[1]

[1]KU Leuven - Gent, Department of Civil Engineering, Building Physics and Sustainable Design, Gebroeders De Smetstraat 1, 9000, Gent, Belgium
[2]Building Physics and Services, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands

ABSTRACT

Resilience performance in building design has emerged as a critical consideration in the face of increasing uncertainties or 'shocks' posed by natural disasters, climate change & excessive pollution. To evaluate and optimize building design decisions, holistic performance metrics are needed. This work defines a novel quantitative assessment framework of indoor air quality (IAQ) resilience which output is the resilience score (**RS**) metric that integrates all resilience aspects and building-relevant pollutants. The framework was demonstrated via simulations on a validated model of a case study educational building in Belgium for 3 ventilations systems: constant air volume (CAV), demand-controlled ventilation (DCV), DCV without filters, and 3 shock types (mechanical **MS**, internal **IS**, outdoor shocks **OS**). Results showed that outdoor shock was the least critical shock type, followed by internal and mechanical shocks. With increasing degree of shock, the **RS** against mechanical shocks decreased for all 3 systems linearly by 64% until 2.8 h of power outage, beyond which the rate of decrease slowed down considerably. CAV & DCV had the same **RS** against mechanical shocks and that of DCV w/o filters was 13% lower. The **RS** against internal shocks for CAV & DCV deteriorated by 38.8% & 46% before plateauing at values of 0.45 & 0.36 respectively. CAV had better resilience against internal shocks. The effect of filters did not reflect in the **RS**. The **RS** against outdoor shocks for CAV & DCV deteriorated by 51% & 26% before plateauing at values of 0.49 & 0.73 respectively. DCV had the best resilience against OS, followed by DCV w/o filters & CAV.

KEYWORDS

IAQ resilience, Quantitative assessment framework, Resilience score, Degree of shock, Indoor air quality