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Overheating risk assessment of naturally ventilated classroom under the influence of climate change in hot and humid region

Kuo-Tsang Huang
Department of Bioenvironmental Systems Engineering, National Taiwan University, Taipei, Taiwan (huangkt@ntu.edu.tw)

Natural ventilation (NV) is considered one of the passive building strategies used for reducing cooling energy demand. The utilization of nature wind for cooling down indoor thermal environment to reach thermal comfort requires knowledge of adequately positioning the building fenestrations, designing inlet-outlet related opening ratios, planning unobstructed cross ventilation paths, and, the most important, assessing the utilization feasibility base on local climatic variables. Furthermore, factors that influence the indoor thermal condition include building envelope heat gain, indoor air velocity, indoor heat gain (e.g. heat discharges from occupant's body, lighting fixture, electrical appliances), and outdoor climate. Among the above, the indoor thermal performance of NV building is significantly dependent to outdoor climate conditions. In hot and humid Taiwan, under college school classrooms are usually operated in natural ventilation mode and are more vulnerable to climate change in regard to maintain indoor thermal comfort. As climate changes in progress, NV classrooms would expect to encounter more events of overheating in the near future, which result in more severe heat stress, and would risk the utilization of natural ventilation. To evaluate the overheating risk under the influence of recent climate change, an actual top floor elementary school classroom with 30 students located at north Taiwan was modeled. Long-term local hourly meteorological data were gathered and further constructed into EnergyPlus Weather Files (EPWs) format for building thermal dynamic simulation to discuss the indoor thermal environmental variation during the period of 1998 to 2012 by retrospective simulation. As indoor thermal environment is an overall condition resulting from a series combination of various factors, sub-hourly building simulation tool, EnergyPlus, coupled with the above fifteen years' EPWs was adopted to predict hourly indoor parameters of mean radiant temperature, air velocity, dry-bulb temperature and relative humidity. These physical quantities are crucial for calculating the thermal indices such as Physiological Equivalent Temperature (PET), New Standard Effective Temperature (SET*), and operative temperature (OT), which were subsequently being used for assessing thermal discomfort. Occurrences and the severity of overheating were assessed by observing the number of hours that surmount the upper limit of the adaptive thermal model proposed by ASHRAE Standard 55 (American Society of Heating, Refrigerating and Air-conditioning Engineers Standard) base on ISO 7730 method to characterize long term indoor thermal discomfort. Preliminary result show that although the degree of increase in overheating risk of NV classrooms was mild, there is a trend revealing that both the occurrences and the severity of thermal discomfort were gradually rising. The study also proposed several building renovation strategies for adapting the climate change to alleviate overheating situation. Efficiencies of these recommended strategies were also analyzed by simulating with the hottest year in comparison with the coldest year.