INDOOR AIR QUALITY IN RESIDENTIAL BUILDINGS AND PLANNING ASPECTS

By

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ABSTRACT

It is a well known fact that people spend 80 – 90% of their time indoors while living, working and commuting. It has also been recognized that the energy consumption in building ventilation represents a significant portion (30 – 60%) of total energy requirement for building operation. There is a conflict between the need to provide better Indoor air quality (IAQ) and to reduce the energy consumption for building ventilation. The ideal solution for this situation could be to improve IAQ with energy efficient ventilation design.

In Sri Lanka, most of the houses are designed with passive techniques to maintain the indoor thermal comfort. The number of hazardous air pollutants CO_2, CO, SO_2, NO_2, Volatile Organic Compounds (VOC), PM_{10}, and $PM_{2.5}$ are on the rise in ambient air, which could make an impact on human health based on different concentrations present in the building. The blame lies to a certain extent on unroadworthy vehicles emitting noxious fumes and to lesser extent on higher density developments that reduces the green cover. CO_2 concentration, although it is a non toxic, can be a direct indication of the ventilation system of the building. Longer exposure to higher CO_2 concentrations can also cause discomfort for the occupants.

When buildings are constructed, various activities can contribute to lower the quality of air. It can occur at different stages of the construction. It can also occur when the building is in use due to building materials used or due to main activities such as cooking, burning garbage, chemicals used in maintenance etc. building ventilation system plays a vital role in maintaining a health indoor environment with better living conditions and indoor air quality.

The study presented in this report includes how the building planning aspects can affect the indoor environment of a building. The main factors considered were the CO_2 concentration and the ventilation design of the building. Under this, area of the openings (void area) of the building was considered as a measure of ventilation. Measurements were taken in residential buildings with varying openings (void) to wall area ratios and openings (void) to Floor area of the selected activity spaces. CO_2 concentration was measured and related with the ventilation design of the space in both free running and air conditioned buildings.

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The other parameters considered in the study are the indoor SO_2 concentration, NO_2 concentration, temperature and relative humidity varying with relevant factors. The factors considered are the type of cooking fuel, vehicle emission coming from the nearby roads, wind speed and the dilution effects of pollutants and also the effect of microclimate on the indoor environment.

As the main findings, the building planning aspects were found to be very important in minimizing the bad effect of pollutants, by diluting the higher pollutant concentrations by providing openings considering wind direction and orientation of the building. Area of the openings in excess of what is provided in the building regulations can improve the ventilation system in a free running building. The operating practices on ventilation system have to be given equal importance as the ventilation design. This has been found as a major factor for a healthy indoor environment.

Considering cooking fuel out of the varieties used in Sri Lanka, fire wood can produce higher SO_2, NO_2, and even higher CO_2 concentrations at the start of the fire. If ventilation system of the kitchen is not operated properly, the situation can become worse with higher pollutant levels persisting for a longer duration. When the coconut husk, leaves and other plant matter is used in the cooking fire, very high SO_2 and NO_2 values were recorded. Therefore, it is proposed to avoid such material used in the fire.

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Although slightly high SO_2 values were observed close to the roads, the dispersion rates are high so that indoor environments are not much affected yet. However, precautions should be taken to introduce cleaner vehicle fuel since a good outdoor air quality is essential for acceptable indoor air quality in free running buildings. It is also important to create better microclimates around the houses not only to act as barriers to the emissions from the vehicle fuel, also it helps to cool down the indoor environment by lowering the temperature by 1.0^0 to 2.0 ^{0}C

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DECLARATION

I declare that this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any University or other institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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