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Sensitivity analysis as a sustainable building design help

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Abstract

In the design of sustainable Buildings it is beneficial to identify the most important design parameters in order to develop more efficiently alternative design solutions or reach optimized design solutions.
A sensitivity analysis makes it possible to identify the most important parameters in relation to building performance and to focus design and optimization of sustainable buildings on these fewer, but most important parameters. The sensitivity analyses will typically be performed at a reasonably early stage of the building design process, where it is still possible to influence the important parameters. The methodology is presented and an application example is given for design of an office building in Norway.

Sustainable building design; heating, cooling, ventilation

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1. Main text

Building performance can be expressed by different indicators as delivered energy use, environmental load and/or the indoor environmental quality and a building performance simulation can provide the decision maker with a quantitative measure of the extent to which an integrated design solution satisfies the design requirements and objectives (Augenbroe and Hensen 2004).

In order to achieve such reductions of the energy use in new buildings it will require development of new construction solutions, new types of building envelopes, and development of new building materials. It will also require the development of more holistic building concepts, sustainable buildings where an integrated design approach is needed to ensure a system optimization and to enable the designer(s) to control the many design parameters that must be considered and integrated (Heiselberg et al. 2006).

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Sensitivity analysis

First, a local OAT sensitivity analysis was used as a screening method in order to evaluate which design parameter is significantly sensitive to building energy performance (Haase et al. 2008).

Then, a global sensitivity analysis method was performed to identify the important design parameters to change in order to reduce the energy use in the reference building (Saltelli et al. 2000). With this method output variability due to one design parameter is evaluated by varying all other design parameters as well, and the effect of range and shape of their probability density function is incorporated. In the analysis a series of parameters were changed and the effect of the changes on the demand for heating, cooling and total energy were evaluated by a dynamic building simulation software package which needs about 10 sec per run. In addition, data output has to be handled manually which takes about 2 min per parameter run. This was rather time consuming even when applying the Morris method (Saltelli et al. 2000), about 220 calculations of output variables are needed for an investigation of 20 variable design parameters.

The calculation of the delivered energy use of the reference office building showed that the heating demand (62 kWh/m2 year) was dominating while the ventilation (35 kWh/m2 year) and lighting (25 kWh/m2 year) demand was lower and demand for cooling was lowest (10 kWh/m2 year).

The sensitivity analysis shows which design parameters are the most important ones to change in order to reduce the energy consumption. The results show that lighting control and the amount of ventilation during winter are the two most important parameters that will have the largest effect on the energy use. This means that introduction of lighting control according to daylight levels and demand controlled ventilation in the heating season are two technologies that should be considered in the next design step.

2. References

Augenbroe, G., and Hensen, J. (2004). "Simulation for better building design." *Building and Environment*, 39(8), 875-877.

Heiselberg, P., Brohus, H., Hesselholt, A., Rasmussen, H., and Seinre, E. "Application of Sensitivity Analysis in Design of Sustainable Buildings." *International Conference on Sustainable Development in Building and Environment*, Chongqing, China.

Haase, M., Andresen, I., Time, B., and Hestnes, A. G. "Sensitivity analysis in the design of climate adapted building envelopes in Norway." *ANZAScA conference*, Newcastle, Australia.

Saltelli, A., Chan, K., and Scott, E. M. (2000). *Sensitivity Analysis*, John Wiley & Sons.

End of extended abstract