"Energy analysis of a glazed building in the summer by means of Computational Fluid Dynamics"

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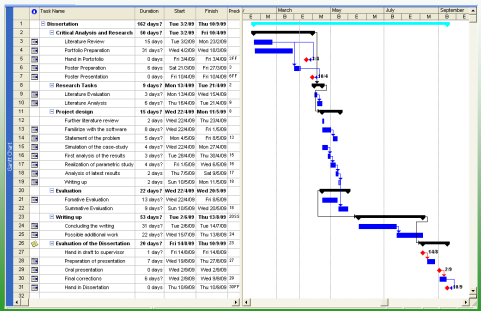
Project Management



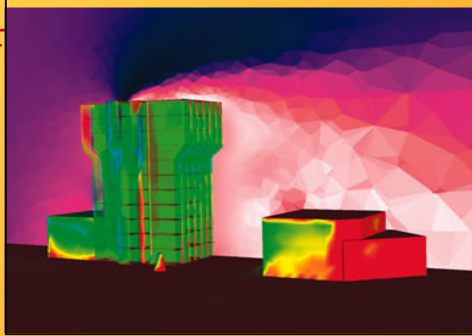
Background

The basic aim of built engineering has always been the ensuring of thermal and optical comfort. Not many years ago, glazed buildings had been characterized as the forerunner of innovative architectural perception. Nowadays, they are the centre of attention due to environmental issues. The energy consumption of a glazed building fluctuates between 450-800kW/m^2 per year, whilst for a conventional building does not exceed 250kW.

A powerful tool that accommodates all complex parameters and equations is computational fluid dynamics (CFD). The development of CFD is based on the fundamental statements of the conservation laws of physics[1]. These principles are generally represented as integral or partial differential equations that are being processed via specific software[2]. CFD provides the possibility to simulate an actual model to a computational one, in order to study and analyze the results. The inside temperature of the room is represented by complex physical phenomena that include optical, thermodynamic and fluid dynamic procedures. All these factors should be taken under consideration when simulating a design in respect to its thermal responses, under the appropriate boundary conditions[3]. The CFD software package that will be used for this project is FLUENT and the building under study is FLUENT Europe's office, at Sheffield, England.

The upgrade of a building ought to be defined by energy and environmental criteria that can lead to an energy reduction of 40%. A representative example of such a practice is the central office of Piraeus Bank, in Athens, where the total energy saving is estimated to exceed 21% of the buildings' total energy consumption and is expected to significantly improve the optical and thermal comfort conditions[4]. The Greek Ministry of Development acknowledging the importance of such interventions has approved the co-financing of the related suggestions.

FLUENTS' "Solar load" model

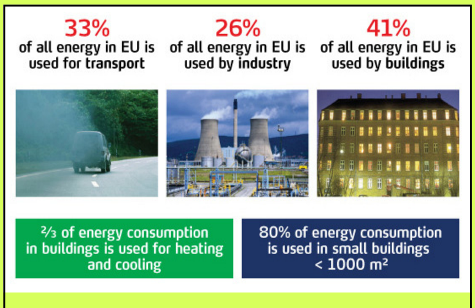


Aims and objectives

The aim of this dissertation is to prove that energy demand for cooling in glazed buildings may be depicted with the use of computational fluid dynamics and analyzed via a software program. Therefore, energy consumption may be controlled and minimized after the conduction of an energy audit.

In order to achieve the aforementioned aim, the following objectives are required to be met:

- ✓ Conduct a literature review that will involve published research reports, articles and books related to the effect of solar loads on glazed buildings and their energy demand.
- ✓ Collect required data regarding the environmental conditions of the buildings' location.
- ✓ Specifically state the problem that is being investigated.
- ✓ Familiarise with the FLUENT software that will be used, in order to be able to comprehend its capabilities and define the case study.
- ✓ Simulate the case study via the "solar load" model.
- ✓ Conduct a parametric study, altering the atmospheric conditions.
- ✓ Compare and evaluate the results.



Energy consumption in EU

Methodology

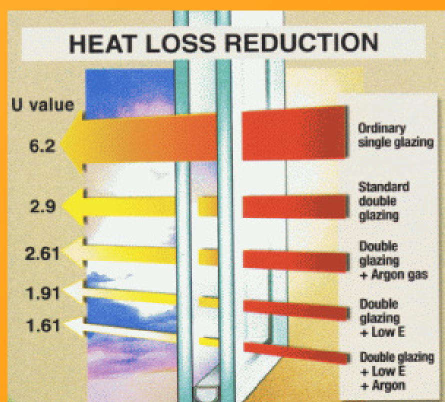
Initially, a literature review ought to be conducted, in order to obtain the appropriate background and an overall perspective regarding glazed buildings' behavior under the impact of solar loads. The research will involve books, journals, articles and dissertations. All gathered material will be evaluated and classified according to its importance for the progress of the study.

In addition, the environmental data that are required for the preparation of the calculations will be collected. Moreover, the computational fluid dynamics' principles will be studied. The CFD effect on the building under study will be represented through complex equations, which are expressed as integral or partial differentials. Their processing will be conducted via the use of computers. For that reason, the familiarization with the software FLUENT is of crucial importance, in order to be capable of providing all necessary data and interpreting the results, whilst obtaining an increased understanding of the software's potentials.

Thereinafter, the case study will be simulated via the "solar load" model. After defining the geometry of the building, the flow model will be defined via computer-aided design (CAD). The result will be depicted in a computational mesh using the pre-processor GAMBIT. Other variables such as the ground-reflectivity and the scattering factor will be taken into consideration. With a view to verify the aforementioned results, a parametric study will be conducted, via altering the atmospheric conditions. The predicted flow data will be presented in a 3-D form. Finally, the results of both simulations will be compared and evaluated, by means of formative and summative techniques.

Outcomes

During the last years respectable research has been conducted in order to promote the development of scientific methods, techniques and technologies that will ensure the maximum energy saving. Computational methods and software, as FLUENT that was utilized during this project, have encouraged research. The energy audit that is being realized in this dissertation represents the primitive step, in order to identify the parameters that affect energy consumption in glazed buildings. Further research could employ the proposition of measures regarding the fabric of the building or its cooling system.



References

[1] H.K. Versteeg and W. Malalasekera, *An introduction to computational fluid dynamics – the finite volume method*. New York: Longman Scientific and Technical, 1995
[2] J.D. Anderson, *Computational Fluid Dynamics – The basics with applications*. New York: McGraw-Hill International Editions, 1995
[3] H. Manz, Th. Frank, Thermal simulation of buildings with double-skin facades, Energy and Buildings (2005)
[4] D. Saelens, "Energy performance assessment of single storey multiple skin facades," Ph.D. Thesis, Catholic University Leuven, Belgium, 2002.