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Improving the sustainable development of building stock by the implementation of energy efficient, climate control technologies

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Abstract

It is the aim of this article to explain the testing procedures developed at the University of Technology, Sydney (UTS) and to evaluate the potential natural ventilation and daylighting applications that have arisen from this research. The objectives for research into this field were to reduce energy costs and increase the sustainability of building stock. From the results of these experiments actual and potential designs are illustrated and discussed in this article. Multi-storey buildings require substantial artificial lighting, even with glass fronted facades, the shaded depths of multi-storey buildings require daylight supplementation and therefore energy. By supplementing the internal lighting levels with daylight, reducing the internal heat load by shading windows to direct radiation and the utilisation of natural ventilation over air conditioning where possible, significant energy savings are achievable. This article explores the heating and cooling problems associated with some glass faced curtain wall multi-storey facades and proposes design changes such as: delivering daylight above the suspended ceiling into the depths of the building by horizontal light pipes and natural ventilation, utilising stack effect and wind siphonage. © 2000 Published by Elsevier Science Ltd.

Keywords: ecologically sustainable development; climate control; daylighting; natural ventilation; stack effect; wind turbines; energy efficiency; curtain walls

1. Introduction

The need to provide climate control inside buildings to improve comfort levels and hence productivity is very desirable. However, the cost of design or redesign to achieve the desired comfort levels has to be economically evaluated.

With the on going energy/greenhouse emission reduction campaigns and in accordance with Environmental and Ecologically Sustainable Development (ESD) principles, the relevance of implementing sustainable energy technologies is now gaining the attention of building designers around the world.

The problems associated with energy consumption such as cost, material depletion both renewable and non renewable and greenhouse gas emissions have provoked an increased awareness and willingness to strive for technologies that provide ameliorative measures which increase the sustainability of building stock.

An area of research that will contribute to reduced energy costs is building facade design implementing natural ventilation and daylighting. The objective of this paper is to highlight the implementation of the technologies and designs that have arisen from research into natural ventilation and daylighting at UTS.

The Construction Management program at UTS has developed a light inlet test building that represents the curtain wall configuration familiar to multi storey buildings. Various methods and means have been evaluated to bring reflected light in above the suspended ceiling and then distribute this light throughout the building.

The Construction Management program and Mechanical Engineering program at UTS have also

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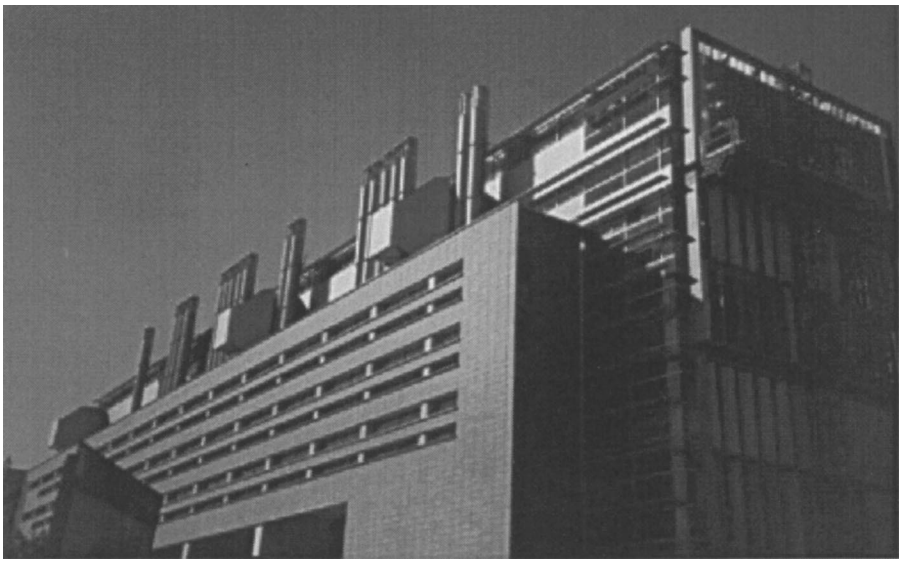

Fig. 1. Science Precinct Building, University of New South Wales, featuring LVT ventilation extraction.

developed a test rig to assess wind driven ventilators. From these results natural ventilation rates can be calculated.

The aim of these projects is to develop a curtain wall panel that provides reduced artificial light dependency, reduced heat load and reduced operating costs, for both air conditioning and lighting.

One of the daylighting devices that has been evaluated involves a solar hood shading device to stop incident radiation from striking the north facing glazing (south in the northern hemisphere) but reflects light through a horizontal light pipe (HLP) above the suspended ceiling and then redistributes that light into the work place (refer to Fig. 2).

2. Background

A curtain wall is usually a non load bearing glass fronted facade hung from the structural frame of a building. This project relates to solar control and more particularly to a method and means for allowing sunlight/reflected light to be redirected internally into buildings by improvements to curtain wall design.

There has been recognition for many years that solar shading using sunhoods/extended eaves etc, enhances the thermal comfort of a building, and winter heating and summer cooling costs are minimised. The standard application is to shade windows from direct radiation during the height of summer while allowing

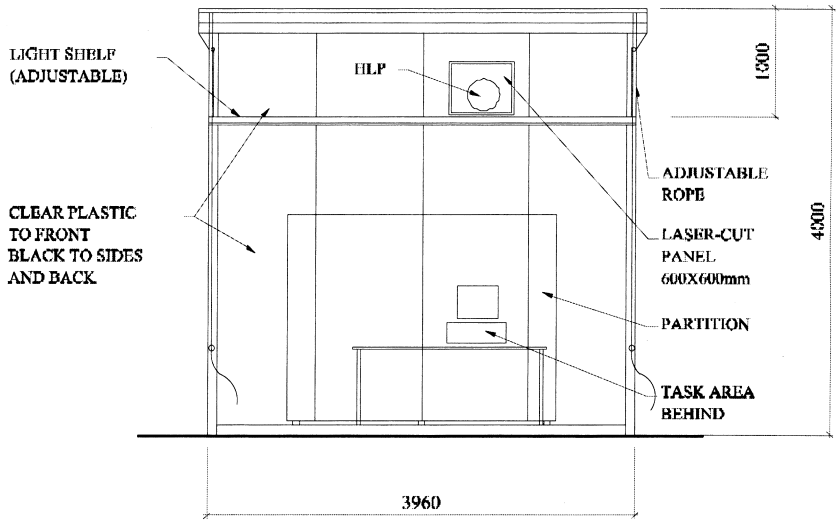

Fig. 2. The Daylighting curtain wall simulation test building, developed by the Construction Management program at UTS.