ISSN: 2348 - 2117

International Journal of Engineering Technology and Computer Research (IJETCR)
Available Online at www.ijetcr.org
Volume 3; Issue 4; July-August-2015; Page No. 01-05

Design and Performance Analysis of Chinmey for Ventilation Space

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Abstract

Natural ventilation of buildings can be achieved with solar-driven, buoyancy-induced airflow through a solar chimney channel. Research on solar chimneys has covered a wide range of topics, yet study of the integration in multi-storey buildings has been performed in few numerical studies, where steady-state conditions were assumed. In practice, if the solar chimney is to be used in an actual building, dynamic performance simulations would be required for the specific building design and climate. This study explores the applicability of a solar chimney in a prototype multi-storey office building. The robustness of the optimized design will be tested at the final stage, against e.g. windows' opening by users. This is an ongoing project; calibration of the solar chimney model and parametric sensitivity analysis are presented here.

Keywords: Ventilation, Thermal comfort, solar chimney

I. INTRODUCTION

The exploitation of sustainable energy sources to cover the functional demands of buildings (for heating, ventilation, cooling etc) can contribute to significant energy savings and thus to alleviation of the current environmental, economic and social problems related to conventional energy practices. Passive (natural) ventilation of buildings is a successful means to save energy otherwise consumed for mechanical ventilation and/or cooling. Solar chimneys (SC) are passive elements that make use of the solar energy to induce buoyancy-driven airflow and naturally ventilate the building.

A SC differs to a conventional chimney in that at least one wall is made transparent; solar radiation enters the chimney through the glazed part and heats up the walls. The temperature of the air inside the SC channel rises due to heat transfer from the walls and the resulting buoyancy drives the airflow through the channel. The SC pulls air from the interior of the building, which is replaced by fresh air through openings or other paths, and natural ventilation is accomplished. Performance of the SC is primarily described by the induced ventilation flow rates; in case heat harvesting is also of interest, air temperature in the channel is the other important performance indicator.

The geometry of the SC channel is described by its height, length and cavity width. The elements of the SC, the terms indicated will be used in the following sections to refer to the solar chimney's parts and geometrical features. Integration of a solar chimney in a building is possible in many ways e.g. as part of the south-facing facade (or the facade where maximum solar availability applies), on the roof (also known as 'roof solar chimney'), in the place of a conventional chimney or as extension of a double facade (usually for multi-story buildings).

II. LITERATURE REVIEW

General Literature Review During the past few decades numerous research studies have been performed on the SC concept, that have deepened our knowledge on the

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performance, the parameters that affect the performance and the applicability of the system for natural ventilation and passive cooling of spaces. The studies can fall under the broad categories of experimental, analytical and numerical modeling studies. A general overview of previous studies based on the above categorization will be presented initially. This section offers a general impression of the various research topics and approaches, and no findings will be reported for brevity reasons. Instead, the findings of parametric analysis studies and of the ones regarding integration in multi-storey buildings will be grouped and presented in two consecutive separate sections, since they are greatly related to the present study.

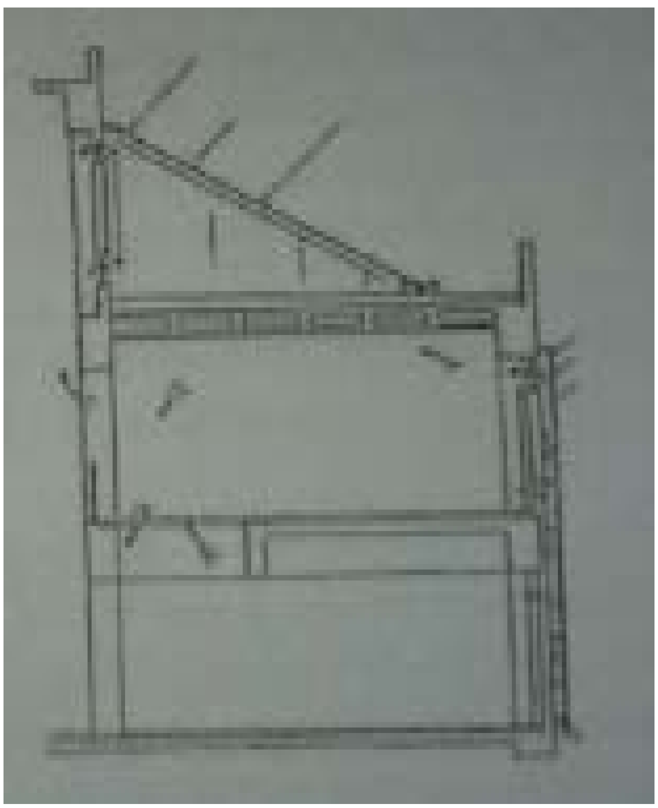

Figure 1:

According to the Farlex dictionary ventilation is defined as replacement of stale or noxious air with fresh air and iteration is needed to provide oxygen for metabolism and utt metabolic pollutants where carbon dioxide and odour the main metabolic pollutants. The highest quality indoor provides by replacing of stale. Higher quality means rtrol of temperature; replenish oxygen, moisture, odour, st, bacteria and carbon dioxide. The simple ventilation ans fresh air is mixed with already existing air in the do sure to dilute the pollutants or used to displace the air means of piston flow. The air change rate affects the collation and fresh oxygen supplied for human comfort rozzi et al. (1992) studied space conditioning in buildings a function of temperature, relative humidity, irradiation d the method of controlling these parameters. The first thematically modeling for the solar chimney (Trombe wall) sign was given by Bansal et al. (1993) and reported the accept of increasing the air flow by increasing solar adiations. This theoretical study also reported an air angle per hour with change in the coefficient of discharge.

>e ventilation provided by the solar chimney is not efficient for large buildings but enhance the ventilation rate to some extent. One important application of passive ogling for air ventilation and circulation in the form of and tower was suggested by Bansal et al. (1994). The solar mine in the form of Trobe wall, roof solar chimney and of air solar collectors are the most convenient and mature: hnologies used for buoyancy driven natural ventilation stems (Khedari et al., 2000; Zhai et al., 2005; Hirunlabh et , 1997). The integrated approach like Trombe wall and of solar collector gives improved rate of ventilation full scale model was built by Kishore et al. (2001) and alyzed it for whole year thermal comfort conditioning, icy used solar chimney for heating in winter season and targeted evaporative cooling approach was suggested for miner. But for rainy season they also controlled the timidity up to some extent by using a dehumidifier. The (% cost was increased by using new approach as compared

Conventional room but in view of comfortless increasing ist doesn't have matter. Miyazaki et al. (2011) predicted e evaporative cooling system experimentally and mulated M-cycle evaporative cooling channel and they und it feasible option of thermal comfort. The system used be capable for 40-50w/m2 radioactive cooling load. The umney width optimized for maximum convective cooling ipacity and air flow rate.

III. PARAMETRIC ANALYSIS

Effect of wall height and cavity width the effect of wall aght and cavity width has in some cases been studied and caressed separately, while in others inextricably, in terms: the height-to- width aspect ratio (also referred to as light-to-gap ratio). Air flow increases with height, since the ick wall's heat gains increase: that an increase in wall height by a quarter is equivalent to an increase in heat gains by three quarters, air flow rates increased in all three assumed locations of the building, by 73% when the v/aO height increased from 3.5 to 9.5m (a cavity width of 0.3m was considered).

i. Effect of inlet size the effect of inlet size was also explored in some studies, and was found to have a wicker effect on the performance compared to that of the cavity width. Increasing the inlet size by a factor of three increased the induced ACH by 11% in the analytical study found that volume airflow rate is a decreasing function of inlet size and claimed rising airflow rates for cavity width beyond 0.3m, as long as the inlet size has the same size as the width.

ii. Effect of inclination angle various inclination angles (15o/30o/45o/60o) were studied experimentally for a constant height, cavity width and uniform heat flux. The air velocity profile across the cavity width was found to be more uniform when the SC was inclined. leading to lower pressure losses at inlet and outlet, and thus to higher airflow rates (45% higher airflow rate was found for the angle of 45o).

On numerically studied the consequences of inclining the SC along the roof line of buildings. They argued that although the heat gains can be favored due to tilt heat transfer between air and glazing is higher, resulting in higher heat losses that could reduce the performance. Higher flow rates by 11% were found (for the optimum angle of 67. *So),* while the performance at 45o angle was almost the same as that of the vertical SC. It is implicit that the impact of SC inclination is highly dependent on the latitude of the location.

iii. Effect of glazing type The use of double glazing can prevent downdraught (and thus reverse flow) along the cold glass surface during winter, but was also found to increase the induced airflow rates up to 17% when applied to a Trombe wall used for passive ventilation in the summer and some argued that double glazing improves the performance of a SC but only marginally, so that it is not a cost-effective measure (only summer conditions were considered).

iv. Effect of climate: (solar intensity and wind). The intensity of solar heat flux is the motive force for the operation of the SC and is thus the most determinant factor for its performance. In varying values were considered for the uniform heat flux on the back wall and the airflow rate was found to rise by -38% for a threefold increase of heat flux (from 200W/m2 to 600W/m2), that airflow rate increases linearly with solar radiation.

IV. WORKING PRINCIPLE OF SOLAR CHIMNEY

The solar chimney is one of the technology which working on the buoyancy principle. Where's the air is heated through greenhouse effect which generated by solar radiation (heat energy).

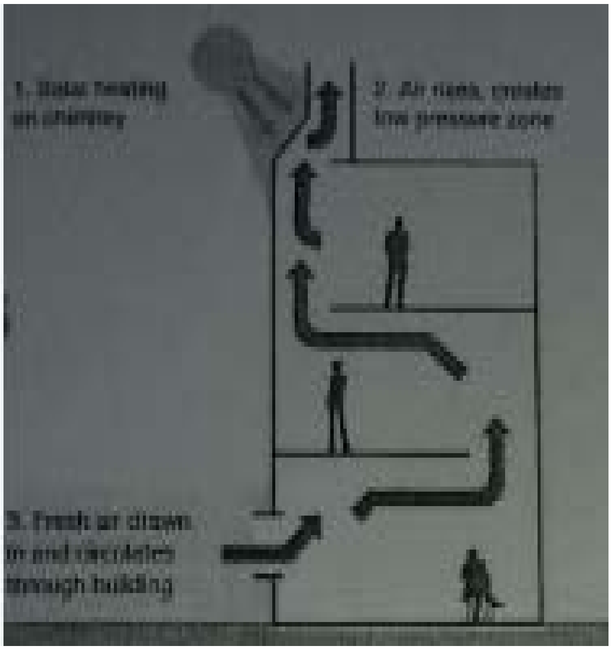

Figure 2:

Unwanted heat during the day and exchange interior (warm) air for exterior (cool) air.

The solar chimney mainly made of a black hollow thermal mass with opening at the top of chimney for exit the hot air. The air passed through the room and exit from the top of chimney. The two purposes are solved one is the better ventilation and secondly it reduces the temperature inside the room. It can be worked as reverse for heating the room also and merits of solar chimney are: Merits: There is no mechanical part, Low maintenance, No electrical Consumption, No global warming, No Pollution and It can be used for both heating and cooling and demerit only is to increases the cost of building. The expenditure involved is not so high. So many techniques can be used in cooling or heating of buildings. The solar chimney can be used in roof level or inside wall also. The solar chimneys are *sola?* passive ventilation systems it means they are non-mechanical. The heat is carried out through convective cooling principle. The solar chimney is designed based on me fact that hot air rises upward.

V. METHODOLOGY

To achieve the aim of the project we envisaged the research methodology which involves the following stages: 1. calibrating the model of the solar chimney with the available data from the small-scale measurements set-up. *2.* Performing Sensitivity Analysis (SA) for a SC design and for the following parameters: length, cavity width, inside face short-wave absorptivity and long-wave emissivity, insulation thickness and thermal mass of the back and side .walls, glazing type and glass percentage of the glazed wall. The performance indicators for the SA are (i) the annual harvested energy (i.e. the air enthalpy gains in the SC) and (ii) the annual fan energy savings. 3. Multi-objective optimization of the SC design to maximize: (i) the air enthalpy gains in the SC that could be recovered and used for e.g. heating purposes and (ii) the fan energy savings. 4. Testing the robustness of the final optimized design using the model of the SC integrated to the model of the prototype building (e.g. influence of operating windows, alternate design for air supply etc.).

VI. CONCLUSIONS

The applicability of a SC for passive ventilation of a prototype. Measurement data in a small-scale SC were used to calibrate and validate the SC model. A case study office building has been chosen and a sensitivity analysis (SA) of a SC design intended for this building was performed. The dimensions of the SC (length and gap width), the short-wave absorptivity of the walls, the glazing type and thermal mass were identified as the most influential parameters with respect to the annual harvested energy in the SC and the annual fan energy savings. At the final stage the integrated model of the SC and the office building will be used.

VII. REFERENCES:

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