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OPTIMIZATION OF SOLAR CHIMNEY FOR VENTILATION SPACES

Chitransh Shrivastava
chitransh.shrivastava@yahoo.in
M.Tech. Scholar, Oriental College Of Technology, Bhopal, M.P., India.
Adarsh Sachdeva[1], Dharmendra Yadav[2]
octadarsh@gmail.com[1]
Dharmendra.dec31@gmail.com[2]
H.O.D., Department of Basic Science, OCT, Bhopal[1]
*** Astt. Prof., Department of Mechanical Engineering, OCT, Bhopal[2]***

ABSTRACT

The objective of this study is to develop a modeling method for optimizing the design of a solar chimney combined conservatory to exploit the airing rate in the conservatory. Solar chimney, frequently specified as a thermal chimney. Thermal chimney is a technique of purifying the normal airing of constructions by using convection of air heated by passive solar energy. In hot climates ventilation can be a useful means of chilling houses, if the outdoor air is colder than inside of house. Often, in hot regions the outside air is so hot during the day that cooling by airing is of no advantage till the sunset when the outdoor air gets chiller. Airing can then be useful, and can be encouraged by a sun-warmed cavity.

Warmness from the sun is deposited in the walls opening the cavity and heats the air inside. The cavity is closed at the top and bottom by inhibitions. These, when opened in the evening, allow the buoyant hot air contained within to rise, drawing cooler outside air into the building. This process continues until the stored energy is consumed. The performance of a characteristic cavity to persuade airing into a house is thoughtful experiment.

Thermal simulations are performed serious in summers. The greenhouse air hotness and its ventilation with numerous geometrical configurations are calculated on the basis of solar irradiance intensity and ambient temperature. The preliminary numerical simulation results show that a solar chimney, combined with an

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appropriately inclined roof of a solarium, would be a better option for ventilation improvement in the solarium. Here, we focus on the recent work on solar chimneys; their construction, creation, custom and their submission.

Keywords: Plywood, Glasses, Black Surface Mat, Temperature Indicator, Thermocouple and Its Wiring, Exhaust Fan's.

1. INTRODUCTION

The types of gear, materials or human action increment the contamination fixation inside the building, which influences to the indoor air quality. Toxin fixation can influence human wellbeing and profitability, which makes essential their evacuation. Generally the ventilation replaces the indoor air for open air, which has better quality. Ecological outline plans to spare the normal harmony amongst man and environment, and to turn back the relationship between man, design and environment to the phase of balance.

The distinctive methods of advancing air trade are mechanical ventilation, which permits controlling the stream rate all the occasion, their quality and temperature; and regular ventilation, which has less support, makes less clamor and does not utilize electric vitality to move the air. The sun oriented smokestack is a framework that uses the sun oriented radiation to move the air, enhancing the characteristic ventilation and now and again giving natural air to the building. This exploration tries to be a stage in transit of track rearrangement by concentrating on a main consideration of latent plan concerning the warm solace and indoor air quality, which is indoor normal ventilation through breaking down and assessing the characteristic ventilation detached procedures.

2. LITERATURE REVIEW

Passive Cooling Techniques for Enhancing the Building Sustainability Development (M.Sc. proposal, Ain Shams University, Cairo, 2010) This examination had characterized the detached procedures because of the cooling techniques. At that point, it talked about the latent contemplations concentrating on the standards and utilizations of normal cooling procedures through hypothetical audit and analysis.

The likelihood of utilizing ordinary climatic medicines inside contemporary design in Egypt (M.Sc. proposition, Ain Shams University, Cairo, 2002) This exploration had presented a systematic study for the ordinary latent procedures and their practical execution.

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Natural Ventilation as a Design Approach for Passive Architecture (M.Sc. proposition, Ain Shams University, Cairo, 1999) This examination presented a logical investigation of common ventilation aloof strategies for cooling and warming inside various. Impact of Building Envelope Design on Thermal Gain and Comfort, An approach for ecological outline of building envelope (M.Sc. theory, Cairo University, Cairo, 2003) This examination had contemplated the impact of engineering sun powered outline on building envelope, delivering a numerical way to deal with study the impact of window designs on warm behavior of building.

The solarium is a fenced in area connected to a house with glass dividers and rooftop. This south-bound space can be introduced in both new and retrofit structures to furnish an agreeable space with positive engineering qualities that can lessen the temperature swings and warming requests of the house, and hence can prompt huge investment funds in the working expenses of the building (Mihalakakou, 2000).

The plan of a solarium or a nursery is critical with respect to warm productivity. As indicated by Bastien and Athienitis (2010), the usefulness of a solarium or a nursery straightforwardly relies on upon the shape and tilt edge. They discovered prominent contrasts regarding sun based radiation retention between various setups of a sunspace. The states of four unique nurseries have been considered by Gupta and Tiwari (2003). They found that relying upon the date, time, shape and size of a nursery, those factors have a significant part in warming a solarium, particularly in the winter.

Tiwari et al. (2002) in their examination on the assessment of sun based division (Fn) for the north mass of a controlled situation nursery affirmed that the dissemination of sun powered vitality on various dividers and entryways of a solarium is an essential calculate foreseeing the execution of the sunroom. Gupta and Tiwari (2003) demonstrated that the floor is as vital as the north divider in the weighted sun powered portion. A model of a joined sunspace has been produced by Mottard and Fissore (2006). They additionally contemplated the solarium as for its measurement, shape and introduction. The study demonstrated a distinction of 3.4% and 11.2% as far as the supplied vitality into the living space by the solarium amid the time span of June and July.

Rodrigues et al. (2000) played out an investigation of sun powered smokestack wind current and its move from laminar to turbulent stream. They utilized a limited volume strategy for their study and they presumed that a proper harmony between warm solace and ventilation ought to be considered in planning the smokestack. They contended that as hole width expands, ventilation rate enhances however the development proportions diminishes.

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Gan (2006) utilized a CFD program to look at the part of various parameters, for example, channel width and floor region on the stream rate. Supplanting external skin with a photovoltaic board was researched in this study. Divider (1997) thought about four distinctive reenactment programs utilized for figuring the sunlight based radiation dissemination in a solarium. The examination likewise underlined the transmission through the coating reflection and assimilation into record. Since numerous studies have demonstrated that the wind impact is significantly more prevailing than temperature lightness (stack impact) in initiating wind stream (Bassiouny, R. and Koura, N.S.A. 2008).

3. WORKING PRINCIPLE OF SOLAR CHIMNEY

The sunlight based smokestack is one of the innovation which dealing with the lightness standard. Where's the air is warmed through nursery impact which created by sun based radiation. The sunlight based stack can be utilized as a part of rooftop level or inside divider too. The sunlight based smokestacks are sun powered uninvolved ventilation frameworks it implies they are non mechanical. The warmth is brought out through convective cooling standard. The sunlight based stack is composed taking into account the way that hot air rises upward; they diminish undesirable warmth amid the day and trade inside air for outside air. **Merits:** There is no mechanical part, Low support, No electrical Consumption, No an Earth-wide temperature boost, No Pollution and It can be utilized for both warming and cooling and fault just is to expands the cost of building.

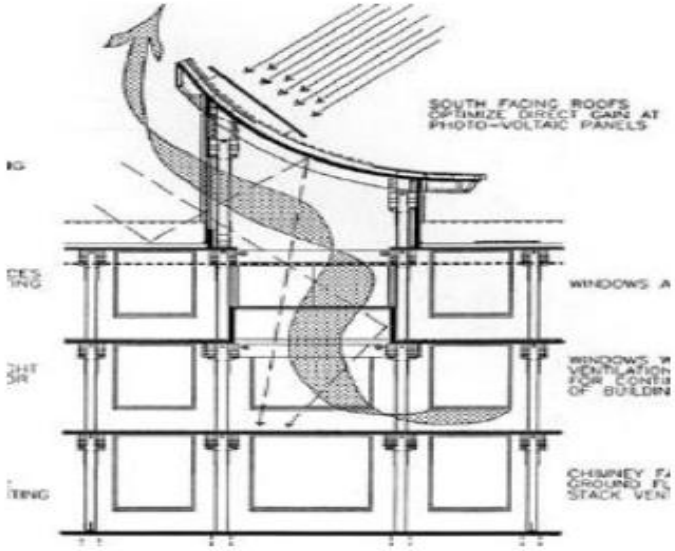

Fig. 1. Natural stack ventilation strategies in modern building

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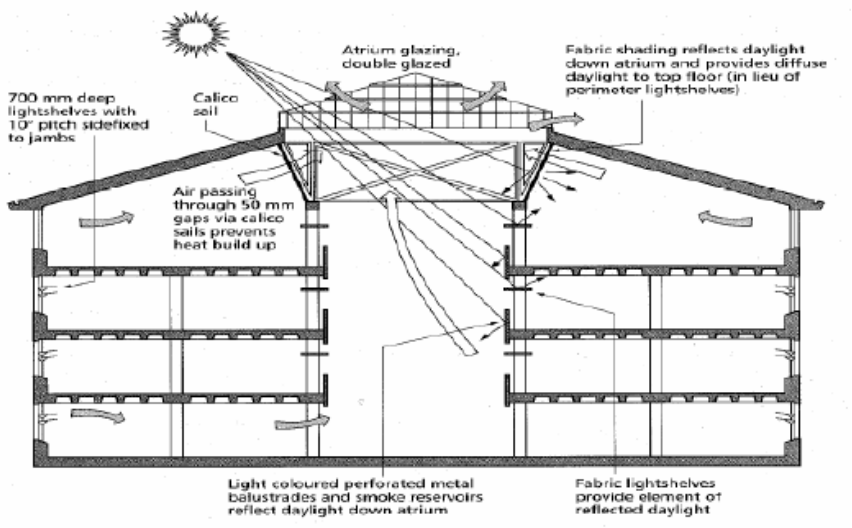

Fig. 2. Double Glazed Atrium

PHYSICAL MODEL:

A straightforward two-story private building has been mimicked with different solariums and the sun based fireplace setups. Parametric studies were done to look at the impact of every plan parameter on the warm conditions in the building. Schematic side area of the SCAS is displayed in Fig. 3. As it is appeared, nearby room air enters the solarium through a base delta. This air then retains vitality in the solarium. The air then enters the sun oriented stack to be further warmed up into the fireplace with the same system as the solarium. The air at last exits into the surrounding air, creating stream from living space to the open air.

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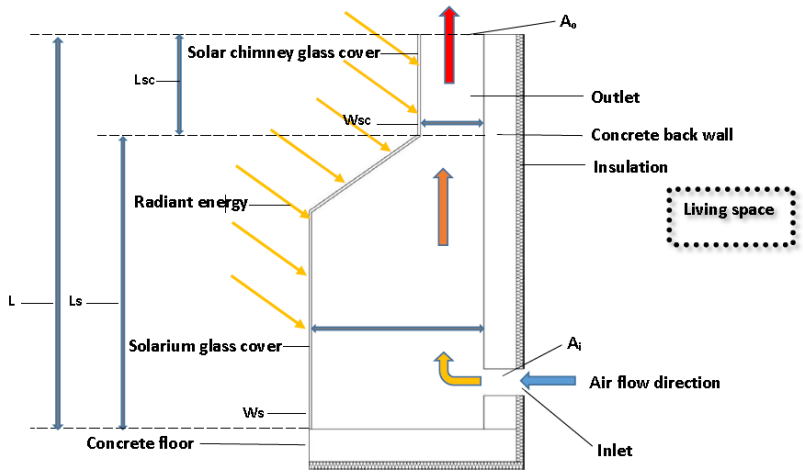

Fig. 3. Schematic side section of the SCAS: Ws and Ls are the width and height of the solarium; Wsc and Lsc are width and height of the chimney

Passive Cooling Strategies

Vitality protection and uninvolved cooling/warming are the most proficient and shoddy contrasting options to customary vitality sources. Most studies in hot atmospheres have uncovered that the most vitality effective spaces are those which utilize inactive procedures for cooling. Latent cooling building plan endeavors to incorporate standards of material science into the building envelope to moderate warmth move into a building and expel undesirable warmth from a building.

Solar Protection

Protection from direct solar radiation may involve: Landscaping, building form, and solar Shading Of Building Surfaces.

Heat Gain Control

Control of warmth pick up manages the protection properties and warm limit of the building materials and structure. The cycle of warmth stockpiling and release must be joined with method for warmth dispersal system, similar to night ventilation, so that the release stage does not add to overheating.

Heat Dissipation

This procedure manages the potential for transfer of overabundance warmth of the working to a natural sink of lower temperature. Scattering of the abundance warm relies on upon two primary conditions: the accessibility of a

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suitable natural warmth sink; and the foundation of a fitting warm coupling between the building and the sink and in addition adequate temperature contrasts for this exchange of warmth.

NATURAL VENTILATION

Ventilation can be viewed as one of the fundamental necessities for the warm solace by controlling temperature, mugginess, air movement, and nature of air with respect to contaminants.

4. TYPE OF SOLAR CHMNEY

The solar chimney is basically a solar air heater-

1. The solar chimney can be classified according the position
(i) Up-and-down solar chimney and
(ii) Inclined solar chimney.
2. It can be classified according to position solar chimney for building (fresh air/machines that bring fresh air) is classified as
(i) Wall solar chimney or Trombe wall
(ii) Roof solar chimney and
(iii) (Combined different things together so they worked as one unit) wall and roof solar chimney.
3.The (fresh air/machines that bring fresh air) rate is mainly depends on the height of solar chimney,
(i) Small height (ii) Medium height and(iii) Large height.
4. The solar chimney is also classified according to the use for
(i) building (fresh air/machines that bring fresh air) (circulation) ii) Building heating / cooling (house/living)
(iii) Air dryer (crop dryer) and (iv) Power generation.

5. RESULTS AND DISCUSSION

THE COMPUTER SIMULATION CODE

As the following stride, a warm reenactment was performed amid the basic summer days utilizing a PC helped procedure executed in SIMULINK toolbar of the MATLAB programming. The program ascertains the nursery air temperature and its ventilation rate for various geometrical designs. This recreation study will likewise be utilized to

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foresee the warm execution of the nursery and the sun oriented fireplace as indicated by the genuine climate information for Toronto and comparing sun powered force and surrounding temperature.

PARAMETRIC STUDY

Keeping in mind the end goal to measure the effect of every variable on the numerical model and reenactment prepare and to decide their ideal measurements to achieve the best ventilation execution in the SCAS, a parametric study has been performed in this exploration. In this procedure, the air mass stream rate through the SCAS has been researched in connection to various factors under the real climate. $\dot{m}$, mass stream rate (kg/s), has been utilized as the execution list of the SCAS. This study covers all the atmosphere parameters with the exception of the twist in the recreation procedure. This study researches the impact of the most compelling parameters on the execution of the solarium, sunlight based fireplace and their cooperation.

ANALYTICAL STUDY

The goal of this study is to break down the warm and element execution of the SCAS with the ideal design. Applying the estimations of parametric study , encourage reproductions have been performed for two distinctive time spans of the entire month of July (trial 1) and July 15-18 (trial 2). The real climate information were connected as passage information of these reenactments. The reason for running the reenactment for two time allotments is that the primary trial gives the entire picture to the hottest month of the year and the second one introduces more engaged results which can be talked about more precisely.

6. CONCLUSION & FUTURE WORK

Conclusion:

The examination got a few conclusions which can be appeared inside the accompanying focuses:

1. Air speed may not really show the ventilation rates thus indoor air quality. This is because of the weight contrasts that outcome a riotous or semistatic air development conditions that influence indoor air quality.
2. Space temperatures don't really reflect warm solace levels where there is no conspicuous connection between lessening in space temperature and improvements of warm solace levels. The outcomes recorded most extreme lessening in space temperature of 2.72°C, with an expansion in agent temperature of 0.17°C inside night west conditions. While with a lessening in space temperature of just 1.55°C, comes about recorded a decrease in agent temperature of 3.65°C inside night east conditions.

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3. High ventilation rates don't really give better warm solace conditions. As the variable of approaching surrounding air temperature is a basic concern. At high encompassing air temperatures, high ventilation rates may raise the agent temperature, and the sentiment distress and disappointment.

4. Double divider tallness does not adversely influence the ventilation rates inside space. This implies twofold divider framework is relevant for application in multi-story structures that fit the nearby contemporary private typology.

FUTURE WORK

1. Different warm mass materials and thicknesses
2. Different bay/outlet setups
3. Different fireplace shapes, for example, round and hollow, pyramidal or cone shaped
4. Different protection materials and applications

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INTERNATIONAL JOURNAL ONLINE OF SCIENCE
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6. REFERENCES

1) Allan, K. , 'Design primer for hot climates',. The Architectural Press Ltd., London, 1980.
2) Golany, C., 'Housing in Arid Lands, Design and Planning', The Architectural, Press Ltd., London, 1980.
3) Bahadori, M. N. , 'An improved design of wind tower for natural ventilation and passive cooling', Solar Energy, Vol. 35, No. 2, pp. 119-129,1985.
4) Warner, C. Y. and Arpaci, V. S. , 'An experimental investigation of turbulent natural convection in air at low pressure along a vertical heated flat plate', Int. J. Heat Mass Transfer, Vol. 11, pp. 397-406,1968.
5) McAdams,. W. H., Heat Transmission, McGraw-Hill, New York, 1954.
6) Rohsenow, W. M. , and Choi, H. Y. , 'Heat, Mass and Momentum Transfer, Prentice-Hall, International, London, 1961. ,
7) Afonso, A., Oliveira, A., 2000. Solar chimneys: simulation and experiment, Energy and Buildings 32: 71-79.
8) Afriyie, J.K., Rajakaruna, H., Nazha, M.A.A., Forson, F.K., 2009. Experimental investigations of a chimney-dependent solar crop dryer, Renewable Energy 34(1): 217-222
9) Afriyie, J.K., Rajakaruna, H., Nazha, M.A.A., Forson, F.K., 2011. Simulation and optimisation of the ventilation in a chimney-dependent solar crop dryer, Solar Energy 85: 1560–1573.
10) Andersen, K.T., 1995. Theory for natural ventilation by thermal buoyancy in one zone with uniform temperature, Building and Environment 38: 1281–1289.
11) Arce, J., Jimenez, M.J., Guzman, J.D., Heras, M.R., Alvarez, G., Xaman, J. 2009. Experimental study for natural ventilation on a solar chimney. Renewable Energy 34:2928-2934.
12) ASHRAE, Handbook: Fundamentals, 2008, American Society of Heating, Refrigeration and Air Conditioning Engineers Inc., Atlanta
13) ASHRAE, 2010. ASHRAE Standard 55: Thermal Enviormental Condi tions for Human Occupancy, American Society of Heating, Refrigeration and Air Conditioning Engineers Inc., Atlanta.
14) Awbi, H.B., Gan, G., 1992. Simulation of solar-induced ventilation, Renewable Energy Technology and the Environment 4:2016-30.
15) Bansal, N.K., Mathur, R., Bhandari, M.S., 1993. Solar chimney for enhanced stack ventilation, Building and environment 28: 373–377.
16) Bargach, M.N., Tadili, R., Dahman, A.S., Boukallouch, M., 2000. Survey of thermal performances of a solar system used for the heating of agricultural greenhouses in Morocco, Renewable energy 20, 415–433.
17) Bassiouny, R. and Koura, N.S.A. 2008. An analytical and numerical study of solar chimney use for room natural ventilation, Energy and Buildings 40:865-873.

ISSN :2455-0108 Impact Factor : 2015-3.462
IJO–Science
INTERNATIONAL JOURNAL ONLINE OF SCIENCE
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18) Bastien, D., Athienitis, A.K., 2010. Analysis of the Solar Radiation Distribution and Passive Thermal Response of an Attached Solarium/Greenhouse, International High Performance Buildings Conference.
19) Barozzi, G.S., Imbab, M.S.E., Nobile, E., Sousa, A.C.M., 1992. Physical and Numerical Modelling of a
20) Solar Chimney-based Ventilation System for Buildings, Building and Environment 27:43-145.
21) Borgers, T.R., Akbari, H., 1979. Laminar flow within the Trombe wall channel, Solar Energy 22:165-174.
22) Bouchair, A., Fitzgerald, D., 1988. The optimum azimuth for a solar chimney in hot climates, Energy and Buildings, 12: 135 – 140.
23) Bouchair, A., 1994. Solar chimney for promoting cooling ventilation in southern Algeria, Building Services Engineering Research and Technology 15(2):81-93.
24) Brager, G. S., de Dear, R. J., 2002. Thermal comfort in naturally ventilated buildings: revisions to ASHRAE Standard 55, Energy and Buildings, 34 (6): 549-561
25) Bryn, I., Schiefloe, P. A., 1996. Atrium models for the analysis of thermal comfort and energy use: a report of task 12, SINTEF Energy, Indoor Environment Technology, Trondheim.
26) Koua K.B. Gbaha P. "Modelling of Thermal Behaviour of a Direct Solar Drier Possessing a Chimney: Application to the Drying of Cassava. A Novel Design for Home Automation by Integrating Solar based System with Internet of Things." *Indian Journal of Science and Technology.* Volume 9, Issue 39, October 2016. DOI: 10.17485/ijst/2016/v9i39/98532
http://www.indjst.org/index.php/indjst/article/view/30294/26226.

27) Yadav Aarti , Mittal Pooja, "A Novel Design for Home Automation by Integrating Solar based System with Internet of Things." *Indian Journal of Science and Technology.* Volume 4, Issue 12, December 2011.
http://www.indjst.org/index.php/indjst/article/view/98532/74198 DOI: 10.17485/ijst/2016/v9i39/98532

28) Visagavel K. , Srinivasan P. S. "Experimental Investigation on Solar Air Heater Assisted Natural Ventilation in Single-Sided Ventilated Room." *Indian Journal of Science and Technology. Volume 3, Issue 7, July 2010*
http://www.indjst.org/index.php/indjst/article/view/29819/25781

29) Senthil Ramalingam , Cheralathan Marimuthu, "Effect of Once-through and Recirculated Fluid Flow on Thermal Performance of Parabolic Dish Solar Receiver. ." *Indian Journal of Science and Technology. Volume 9, Issue 33, September 2016.* http://www.indjst.org/index.php/indjst/article/view/89084/73067. DOI: 10.17485/ijst/2016/v9i33/89084