International Conference On Emerging Trends in Engineering and Management Research
NGSPM's Brahma Valley College of Engineering & Research Institute, Anjaneri, Nashik(MS) (ICETEMR-16)
23rd March 2016, www.conferenceworld.in ISBN: 978-81-932074-7-5

STUDY OF CHARACTERISTICS OF AIR FLOW FROM OPEN WINDOWS

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ABSTRACT

In natural ventilation systems recent air is usually provided through gap of windows. However, the data of the performance of windows is quite restricted, particularly with relevancy their impact on thermal comfort and draught risk within the occupied zone. This paper describes and summarizes the results of a series of laboratory measurements that's performed on 2 completely different window sorts to see the characteristics of the air flow in rooms. It's shown that the air flow may be represented by ancient theory for jets and stratified flow and semi-empirical flow part models square measure developed for estimation of thermal comfort parameters within the occupied zone.

Keywords: Natural ventilation;Cross ventilation; Stack ventilation;Main topic.

I. INTRODUCTION

In many western countries around 1/2 the energy consumption is employed for heating, cooling and ventilating buildings. Even if reduction of this energy demand gets lots of focus still it's necessary to think about other ways to avoid wasting energy with the unstable oil costs and also the unsure political state of affairs within the oil manufacturing countries. a median person these days spends regarding ninetieth of his time inside. Therefore, it's vital to keep up specialize in an honest and healthy indoor setting, however this doesn't exclude saving energy. To be additional freelance of the oil as associate degree energy supply and additionally to cut back the damaging shops to the setting, associate degree increasing use of property technologies like solar power, higher use of day lightweight and use of natural ventilation is additional and additional typically mentioned once new buildings area unit designed and designed or recent ones area unit restored. sadly, not all property technologies is utilized in all climates, since the atmospheric condition area unit a very important think about these technologies. Considering natural ventilation it is troublesome to stay stable indoor conditions, since outside atmospheric condition typically modification. Not all climates and kinds of buildings area unit appropriate for natural ventilation, and since of the restricted natural driving forces and cooling capability of outside air this kind of ventilation sets some needs for e.g. internal heat load within the building, depth of the rooms, space height and surroundings, however natural ventilation is turning into additional and additional common once solutions for ventilation of faculties and offices area unit being designed. what is more, the natural ventilation also are be used for passive cooling of the buildings throughout night, wherever the cold outside air will facilitate quiet down the building additionally with energy savings as a result. Once natural ventilation is employed as ventilation principle it's vital to be ready to predict the flow rate through the windows to be ready to management and provide the correct quantity of contemporary air to the rooms within the building. This can

be to get an honest and healthy indoor setting and at an equivalent time to avoid supererogatory high flow rates leading to high-energy consumption for heating. Within the case of cross-ventilation the quantity of air probing the openings area unit affordable well outlined. Sadly, this can be not the case for single-sided natural ventilation, wherever the calculation of flow rates still is inaccurate since the flow method isn't well-known and unsteady further. Besides being keen about wind speed, wind direction and temperature variations between within and out of doors the building, the flow in single-sided ventilation is additionally influenced by the turbulence characteristics (turbulence intensity and length scales) within the wind and also the variation in pressure variations evoked by e.g. wind gusts. Since these parameters area unit unsteady the flow in single-sided ventilation is far tougher to calculate. Throughout the years some work has been created to widen the data of those parameters that has crystal rectifier to totally different empirical expressions developed on the idea of construction experiments and/or all-out outside experiments. From the data obtained in construction experiments it's been the aim of this work to create a replacement style expression for the flow rate that features wind direction, temperature distinction and wind speed beside the impact on the flow rate coming back from the unsteady effects within the wind close to the gap. a transparent dependency between the wind direction and also the quantity of air probing the gap was found. This dependence isn't enclosed in earlier investigations. Throughout the experiments it had been additionally found that the flow would possibly modification from being dominated by wind speed to being dominated by temperature distinction once the magnitude relation between the 2 forces is dynamical. This modification is additionally found within the form of the speed profiles measured within the gap.

II. LITERATURE REVIEW

"Natural ventilation is that the method of supply and removing air through an inside area by natural means".

Single sided ventilation :restricted to zones near the openings.

Cross ventilation :2 or a lot of openings on opposite walls-covers a bigger zone than the single-sided openings.

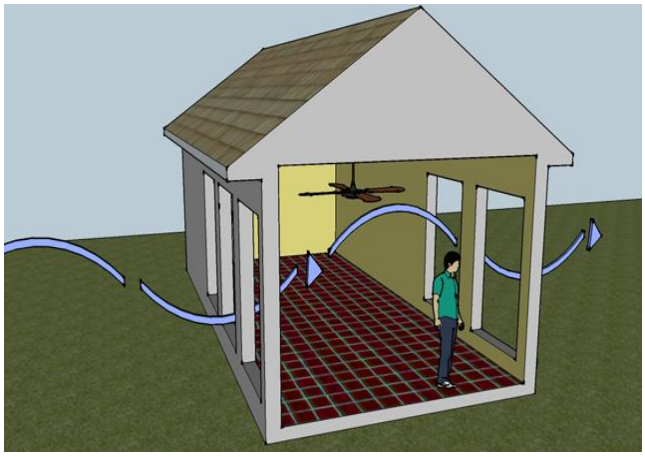

Fig.2.1cross ventilation

Stack ventilation: Buoyancy-driven offers larger flows

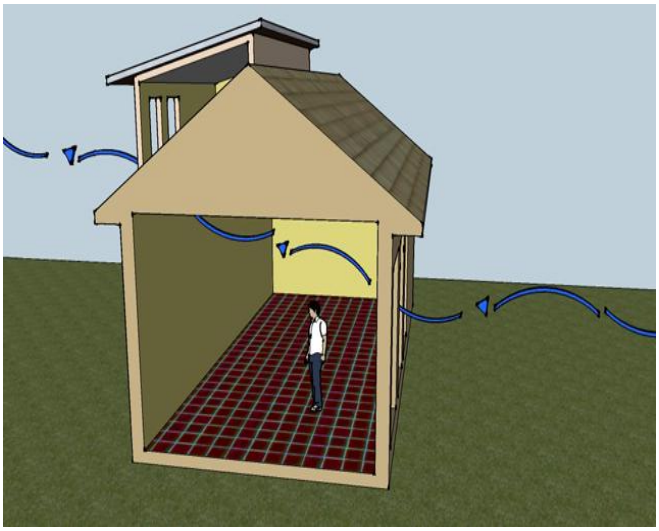

Fig.2.2 stack ventilation

Windcatchers :-Wind and buoyancy driven -effective in heat and temperate climates.

Solar indusedventilation :-mistreatment the sun to heat building parts to extend buoyancy -more effective in heat climates

Hybrid Ventilation :-The flowing is thanks to wind and buoyancy through designedly put in openings within the building envelope supplemented, once necessary, by mechanical systems.

III. METHODOLOGY

Existing empirical expressions for single-sided natural ventilation

Empirical expressions for calculation of the flow through openings in single-sided natural ventilation have earlier been investigated and developed. This section contains existing expressions from literature for calculation of flows in cases with airflow driven by thermal buoyancy, by wind and by each thermal buoyancy and wind.

Air flows driven by thermal buoyancy

The flow driven solely by thermal buoyancy during a single gap are bidirectional with heat indoor air flowing move into the highest of the gap and cold outside air flowing in at rock bottom of the gap. this suggests that the direction of the speed changes at the amount of the neutral plane within the gap. the quantity rate during this case are often found from expression (3.1) derived in [6].

$$V = \frac{1}{3} C_D \cdot A \sqrt{\frac{(T_i - T_e) \cdot g \cdot (H_t - H_b)}{T}} \qquad \ldots\ldots\ldots(3.1)$$

where V is that the volume rate (m^3/s), Cd the discharge constant, A the world of the gap (m^2), Ti the interior temperature (K), Te the external temperature (K), T the common temperature (K), g the gravitative acceleration (m/s^2), Ht the peak, high of the gap (m) and haemoglobin is that the height, bottom of the gap (m).

Air flows driven by wind

Since the ventilation rate in single-sided ventilation isn't solely driven by the mean wind speed however additionally by turbulence within the wind and fluctuations in pressure at the gap these parameters must be taken into thought once the flow caused by wind is calculated.

In 1977, Warren revealed work on turbulent convection of airflows through one gap [5]. The most plan in turbulent convection is that solely eddies sized smaller than or adequate to the window size can contribute to the ventilation of the area. The ends up in Warrens work were found from single-sided ventilation experiments in each all-out and structure tests. The results were improved in later work [6] however during this early work it absolutely was investigated however the quantitative relationbetween the native wind speed before of the gap (UL) and a reference wind speed (UR) depends on the angle of incidence of the wind. The results show that the native speed is incredibly a lot of obsessed with the wind direction. The explanation for this can be that the flow pattern on the wall with wind direction and square measure utterly completely different from leeward facet weatherboard weather side windward side. Additional analysis created by Warren expressed, by the mathematician range, that a distinction between the wind dominated and temperature dominated cases exist. From this it absolutely was over that resultive} thanks to handle the mix of wind and buoyancy was to calculate the effect from every parameter singly and so use the most important of them [5]. In later work created by Warren and Parkins [6]

The expressions found in [5] was improved by as well as new theoretical concerns of each structure and all-out experiments. During this later work 2 expressions were derived. These failed to embody the impact of temperature distinction, and additionally it absolutely was noted that higher rates is also achieved for alternative combos of windows, bound wind directions and tall buildings. The expressions square measure shown in (3.2) and (3.3).

$$V = 0.1 \cdot A \cdot U_L \qquad \text{..... (3.2)}$$

$$V = 0.025 \cdot A \cdot U_R \qquad \text{..... (3.3)}$$

where UL is that the native speed before of window (m/s) and Ur is that the reference wind speed (m/s).

Another analysis of the flow caused by wind was created within the work of Cockroft and Oscar Robertson. Here a theoretical pulsation model was made up of a study of one gap pulsation flow [7]. It absolutely was solely the low frequency rhythmic flow that was enclosed in their model, which implies that flow caused by turbulence was unnoticed during this work. The expression was found through analysis and was tested during a structure experiment. The expression provides a suggestion on however the rhythmic flow are often set from the modification in volume (v) and is seen in (3.4).

$$V = \frac{d\omega}{dt} = \pm C_D A \sqrt{\left| U^2 - \left(\frac{2\gamma P_a}{\rho V}\right)\omega \right|} \qquad \text{.....(3.4)}$$

where dω is that the modification in volume of the initial mass of air within the area (m3), t the time (s), U the mean wind speed (m/s), γ the polytrophic exponent, V the area volume (m3), and P is that the air pressure (Pa). The polytrophic exponent (γ) is adequate to one.4 for adiabatic flows and 1.0 for equal flows [8]. CD is found to be 0.65. Cockroft and Oscar Robertson points out that the parameters in (3.4) rely on the form and size of the gap, the external flow, the overall flow through the gap and also the internal volume. Cockroft and Oscar Robertson additionally mentioned whether or not all incoming air contributes to the effective ventilation since a number of theair shortly once coming into can leave the area once more thanks to the fluctuations. They thus

outlined an efficient ventilation rate and over in their work that thirty seventh of the flow rate contributes to the effective air modification, that was measured by the tracer gas decay methodology. Constant comparison has been created during this current work wherever measurements of flow rates created with the tracer gas decay methodology were compared to measurements created by the speed sensors within the gap. From speed the speed the rate measurements the flow was calculated by multiplying the measured velocity with the corresponding space. During this case the deviations between the 2 strategies were solely found to be between 10 and 20%. Another definition of the form of the speed profile may modification this result. Crommelin and Vrins [8,9] developed correlation strategies for calculation of wind driven single-sided. Through tracer gas experiments created during a structure they found a correlation between the quality deviation of pressure and also the wind rate and between the flow and each the quality deviation of pressure, the wind rate and also the space of the gap. Additionally the variation in flow rates caused by completely different incidence angles of the wind were investigated during this work and dependence was shown however this wasn't enclosed in their final expression. All the expressions, that square measure shown in (3.5)–(3.7) were supported empirical coefficients.

$$\sigma_{\Delta p} = \alpha_1 U^2 \qquad \text{…….. (3.5)}$$

$$V = \alpha_2 \sigma_1^{\beta 1} = \alpha_1^{\beta 1} \alpha_2 U^{2\beta 1} \qquad \text{…….. (3.6)}$$

$$V = \alpha_3 A^{\beta 3} \qquad \text{…….. (3.7)}$$

whereσΔp is that the variance of pressure (m/s). Crommelin and Vrins found for an upstream length of 0.35 m that α1 = 0.029, α2 = 0.0018, α3 = 0.0608, β1 = 0.32 and β3 = 0.92.

IV. AIRFLOWS DRIVEN BY THERMAL BUOYANCY AND WIND

The literature on single-sided ventilation driven by each wind and thermal buoyancy is scarce, however Diamond State Gids and Phaff created some all-out experiments in 1982 as well as each parameters [2]. Their work additionally enclosed a discussion of the difficulties to find the form of the speed profile within the gap since this may modification reckoning on that of the 2 parameters (wind and thermal buoyancy) that dominate. The experiments in their work were dispensed at 3 completely different locations on buildings in urban setting with encompassing buildings up to four floors high. All measurements were created on the primary floor of the building. The experiments consisted of measurements of wind speeds, window and area air velocities, air-change rates and temperature. the overall range of measuring cases was thirty three. From the experiments the subsequent expression was found:

$$U_m = \sqrt{(C_1 \cdot U_{10}^2 + C_2 \cdot h \cdot \Delta T + C_3)} \qquad \text{…… (3.8)}$$

where Um is that the mean air rate in gap (m/s), U10 the mean wind speed in H = 10 m (m/s), h the peak of the gap (m), T the temperature distinction (K), C_1 the dimensionlesscoefficient reckoning on the wind impact, C_2 the buoyancy constant, and C_3 is that the turbulence constant. The constants were found as a best suited the thirty three measurements. The values in (3.9) were found.

$$U_m = \sqrt{(0.001 \cdot U_{10}^2 + 0.0035 \cdot h \cdot \Delta T + 0.01)} \qquad \text{……(3.9)}$$

To be ready to notice the quantity rate from the mean rate in (3.9) expression (3.10) is employed.

$$V = A_{eff} \cdot U_m = \tfrac{1}{2} \cdot A \cdot U_m \qquad \text{……...(3.10)}$$

whereAeff is that the effective space used for recess (m^2) and A is that the total space of the window (m^2).

On the contrary to most alternative expressions this work doesn't think about the employment of a CD-value. The CD-value is enclosed in Um. This call makes the accuracy of the calculation obsessed with window sort since it's unimaginable to alter the characteristics of the window within the expression just by dynamical the CD-value. the worth 1/2 is more to seek out the quantity rate, that comes from the actual fact, that solely 1/2 the window space is employed as recess.

V. CONCLUSION

During studies of earlier work created within the space of natural ventilation some totally different and unresolved queries popped up concerning the parameters that influences the flow of air throughopenings in natural ventilation. one among the most queries was however the angle of incidence of the wind may be enclosed in predictions of the flow of air through openings. Earlier work by e.g. Warren and Parkins and First State Gids and Phaff has tried that some dependence exists however neither of them has the wind direction enclosed in their style expressions created for single sided ventilation.

To analyze that parameters that affects the air-change rate, experiments were created with single-sided natural ventilation during all-out construction building. From the experiments within the construction it absolutely was ended that the air amendment rate depends on the angle of incidence. It absolutely was conjointly found that the dominating force (wind pressure or temperature difference) changes as a perform of angle of incidence. a similar variation between temperature dominated Associate in Nursing wind dominated cases were found in an analysis of the speed profiles within the gap measured at totally different incidence angles. From the construction experiments a brand new style expression was started that makes it doable to predict the flow of air in single-sided natural ventilation together with the result from totally different incidence angles. The look expression is split into 3 cases (windward, leeward or parallel flow) as a result of totally different flow patterns close to the gap. The uncertainty within the predictions is found to twenty third, that is Associate in Nursing improvement compared to earlier expressions.

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