Wind Engineering Joint Usage/Research Center
FY2023 Research Result Report

Research Field: 室内環境分野
Research Year: FY2023
Research Number: 23232005
Research Theme: Research on Air Conditioning Vent Outlet Airflow Velocity, Distance, and Comfort

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Budget [FY2021]: 420000Yen

*There is no limitation of the number of pages of this report.
*Figures can be included to the report and they can also be colored.
*Submitted reports will be uploaded to the JURC Homepage.

1. Research Aim

(1) Explore the impact of buffering methods, static pressure box height and air outlet style on comfort
(2) Development of terminal air supply equipment
(3) Make suggestions using experimental data results

2. Research Method

This study uses actual wind speed measurement as the experimental method. First, this study develops an air outlet that includes joints, static pressure boxes, and air outlet styles. Comparative experiments are conducted with commercially available air outlets and homemade air outlets. ,The experiment is divided into two stages, the first stage is ,measurement of wind speed, and the second stage is visualization ,experiment.

3. Research Result

(1) To reduce the overhead wind speed and the average wind speed on the outlet surface, you can use a side joint static plenum box with a higher height static plenum and change the outlet surface style.
(2) To improve uniformity, you can select a side joint static plenum and change the air outlet style.
(3) Efficiency If you want to improve efficiency, you can choose the upper joint static pressure box and change the style of the air outlet surface.

4. Published Paper etc.

[Underline the representative researcher and collaborate researchers]
[Published papers]
1.

[Presentations at academic societies]
1.

[Published books]
1.

[Other]
Intellectual property rights, Homepage etc.

5. Research Group

1. Representative Researcher
Chen-Yu Pan

2. Collaborate Researchers
1. Yu-Ju Chen

6. Abstract (half page)

Research Theme: Research on Air Conditioning Vent Outlet Airflow Velocity, Distance, and Comfort
Representative Researcher (Affiliation)
Summary・Figures

1. INTRODUCTION

Office workers stay in the indoor space for a long time, the indoor thermal comfort is gradually being emphasized, through the investigation of this study, the ceiling height of 2.4 meters ~ 2.6 meters of the old office space accounted for 38%, the central air conditioning system sends out airflow for a constant temperature and humidity, but each person's indoor comfort is not the same, and the ceiling height of the various office spaces will be different due to the interior decorations. Each office space also has different ceiling heights due to the interior decoration, so the use of appropriate air outlets is a key factor in improving indoor comfort. In addition, because of the low ceiling height, it is common that the distance from the ceiling to the top of the head of the user is only about 1.2 meters in old offices, which leads to the phenomenon of windshock caused by air conditioning blowing directly onto the human body. Therefore, this study focuses on the design of air-conditioning outlets - wind speed, distance and comfort.

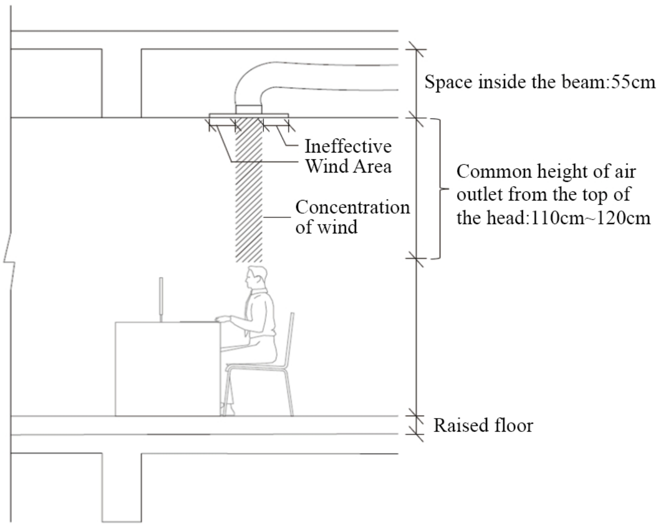


Figure 1. Common conditions of air-conditioning vents and users in old offices

2. EXPERIMENTAL

This study adopts a practical measurement method, using a hot-wire anemometer to measure the wind speed and a smoke machine to visualise the air flow. These two measurement methods complement each other, providing concrete data support on the one hand, and demonstrating the air flow status intuitively through visualisation on the other. The focus of the evaluation is on the airflow efficiency (i.e. the average air velocity at the outlet) and uniformity (the uniformity of the air velocity at the outlet), which are compared to each other for the purpose of analysing and evaluating the airflow conditions

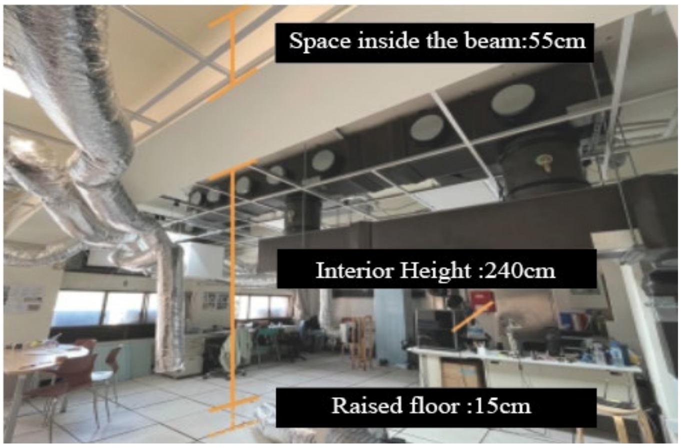


Figure 2. Experimental Space

Figure 3. Thermal Anemometer

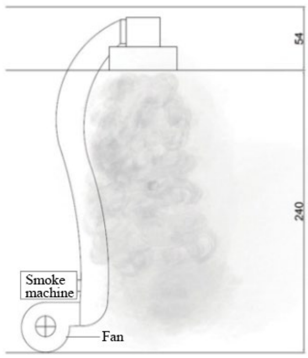


Figure 4. Fans are used to send smoke to the air outlet

There are three criteria for assessment 1. The smaller the standard deviation 2. Outlet air efficiency between 2.5m/s ~ 3.5m/3. Overhead wind speed of 0.3m/s-0.5m/s.Uniformity in accordance with the standard deviation formula, the formula is

$$s = \sqrt{\frac{\sum (x_i - \overline{x})^2}{n-1}} \qquad (1)$$

s = sample standard deviation

xi = individual values of the data, i=1~n

n = number of data

In this study, the design of the downdraft air outlet is modified to involve three main variables. Firstly, there is the type of receiver, which is divided into two types: top receiver and side receiver, which affects the receiver state and thus the buffering and mixing of airflow. The second variable is the height of the plenum box. In this study, the height is divided into five heights, such as 2cm, 6cm, 10cm, 15cm and 20cm, which affects the effect of the secondary homogeneous mixing of the airflow. The third variable is the type of air outlet, which includes nine round holes, sixteen round holes, dense round holes, and square holes, which is predicted to have an effect on the airflow pattern.

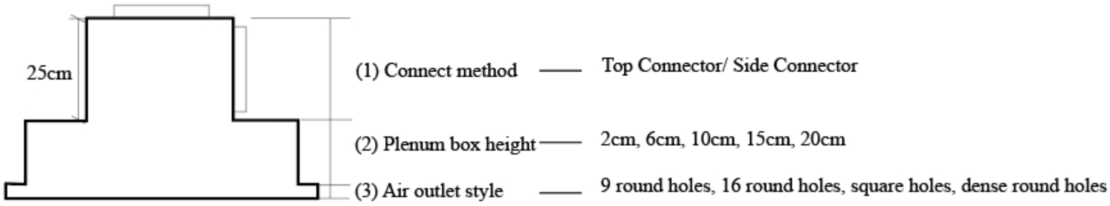
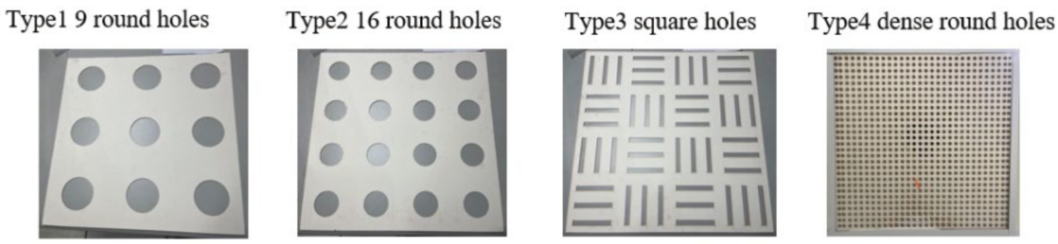


Figure 5. Air Outlet Design

These four types of outlets, the same opening rate, changes in the shape of the hole, hole area and number of holes, etc., it is predicted that these changes will have an impact on the airflow pattern of the outlet, perhaps at the same rate of opening, the changes in the shape of the hole and the number of holes will have a different impact on the effect of the outlet and the distribution of airflow, and this subtle difference may be able to bring about unexpected changes in the characteristics of the airflow, which will in turn affect the overall quality of the air flow.



	Hole shape	Hole area(cm^2)	Number of holes	Total opening area(m^2)	Porosity
Type1	circle	75.9261	9	0.0683	0.19
Type2	circle	42.709	16	0.0683	0.19
Type3	square	14.0102	48	0.0672	0.19
Type4	circle	0.7854	870	0.0683	0.19

Figure 6. Four types of air outlet design

3. RESULTS AND DISCUSSION

The results of the experiment are presented in three comparisons, the first is to compare the way of con-nectors, the second is to compare the height of the plenum box, and the third is to compare the style of the air outlet.

Figure 7 shows The side connector is better than the top connector in terms of air distribution uni-formity, which is a significant difference under the same static pressure box height and style.

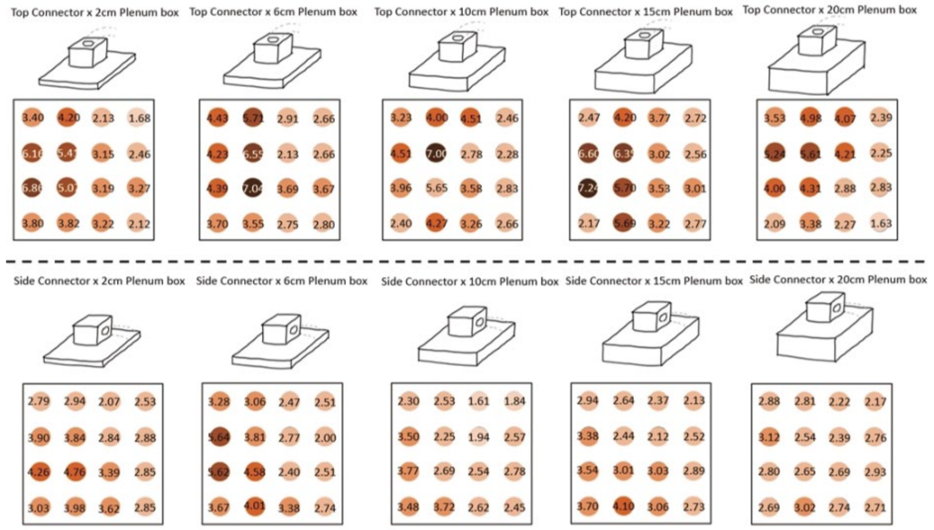


Figure 7. Compare the effect of top and side connectors.

Table 1 shows the experimental results do not show any significant regularity in terms of the height of the variable bi-static box.

Table 1. Compare the effect of static Plenum box height

	Side Connector Overhead Air Velocity	Top Connector Overhead Air Velocity
9 round holes	6cm < 2cm <10cm<15cm<20cm	15cm< 10cm < 2cm <20cm <6cm
16 round holes	6cm < 2cm <10cm<15cm<20cm	10cm< 2cm < 15cm <6cm <20cm
dense round holes	2cm < 20cm <10cm<6cm<15cm	6cm< 10cm < 20cm <2cm <15cm
square holes	6cm < 2cm <15cm<10cm<20cm	2cm< 10cm < 15cm <6cm <20cm

Figure 8 shows the Changes in outlet style have little or no significant effect on air uniformity.

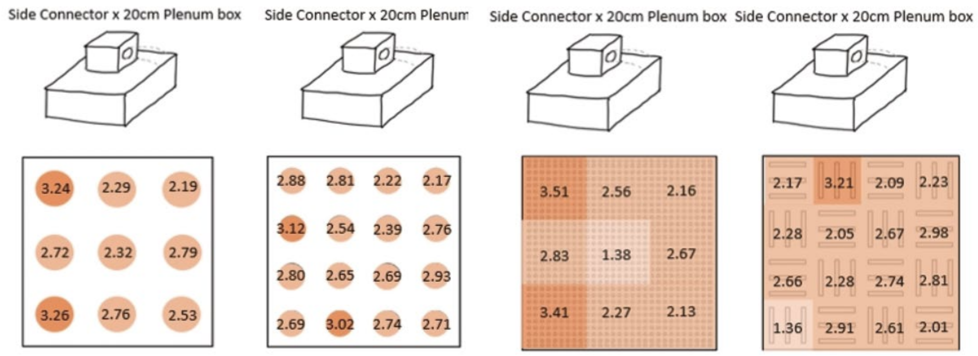


Figure 8. Compare the effect of outlet style

4. CONCLUSION

Comparing the uniformity, efficiency and head wind speed of 40 types of outlets, the uniformity was ranked from high to low, the first stage eliminated outlets with efficiency less than 2.5m/s and more than 3.5m/s, and the second stage eliminated outlets with a head wind speed of less than

0.3m/s. In the end, there were only three outlets that met the filtering criteria, which were the 20cm static pressure box for the side connector and the 16-hole outlets for the TYPE2. In the end, only three outlets met the screening criteria, namely, the side connector with 20cm static pressure box and TYPE2 16-hole outlet, the side connector with 20cm static pressure box and TYPE1 9-hole outlet, and the side connector with 10cm static pressure bo

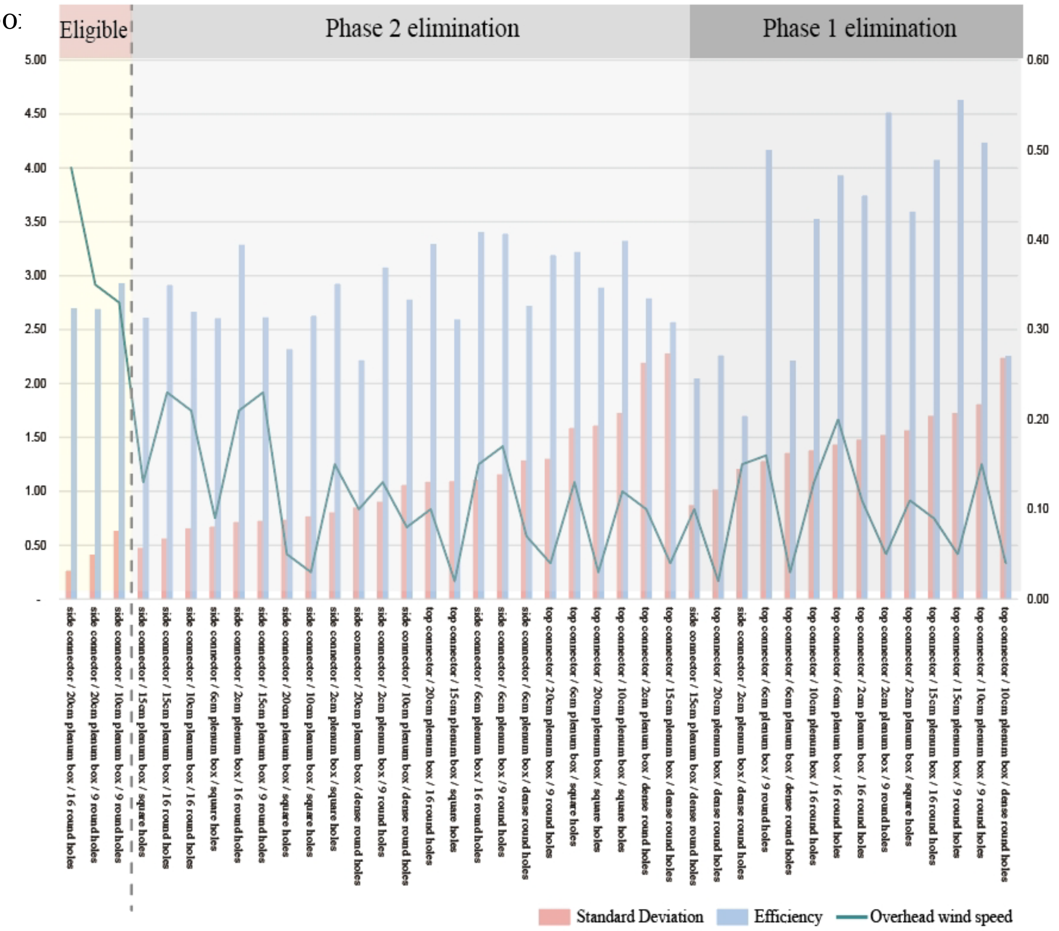


Figure 9. Comparison of the uniformity, efficiency and head wind speed of 40 types of outlets.

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