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SUPPLY PLENUM, SUPPLY AIR VOLUME AND AIR FLOW UNIFORMITY IN CLEANROOMS

Prof. Dr. Eng., Jang Yeul Sohn, Dept. of Architecture, Hanyang University, 17, Haengdang-dong, Sungdong-ku, Seoul, 133-791 South Korea

Doctral student, Hyun-Jae Chang, Dept.of Architectural Eng., Hanyang University, 17, Haengdang-dong, Sungdong-ku, Seoul, 133-791 South Korea

Doctral student, Woo-Sik Shim, Dept.of Architectural Eng., Hanyang University, 17, Haengdang-dong, Sungdong-ku, Seoul, 133-791 South Korea

Representative, Chang-Soo Kim, Samwoo Architects&Engineers, Hanwon Building, 1449-12 Seocho-dong, Seocho-ku, Seoul, 137-070 South Korea

ABSTRACT

Air flow distribution in cleanrooms is up to the state of flux in supply plenum which is mainly affected by the height of it.

The purpose of this study is getting fundamental knowledge for determining optimum height of supply plenum through the close examination of correlation between the height of supply plenum, supply air volume and air flow uniformity in cleanrooms.

1. INTRODUCTION

Cleanrooms which are developed by the exceeding of a precision instrument and aircraft industries in 1950's are being expanded to many fields centering semiconductor industry and are prospected to take important positions in future industries.

Studies on cleanrooms have achieved significant results. However, on air flow uniformity concerned with the state of flux in supply plenum, the correlation between them isn't examined closely yet. So, the height of supply plenum is designed by experience and so highly in actual affairs.

Experiment was carried out to get fundamental knowledge needed for determining optimum height of supply plenum in the experimental cleanroom of Open Bay Type.

2. EXPERIMENTAL APPARATUS AND PROCEDURE

Figure 1 shows the section of the experimental cleanroom. Experimental cleanroom which is

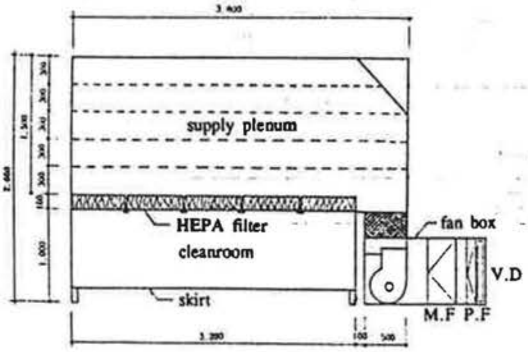


Fig.1 Section of the experimental cleanroom

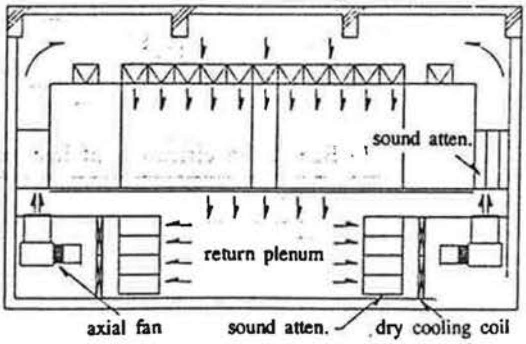


Fig.2 Open Bay Type cleanroom

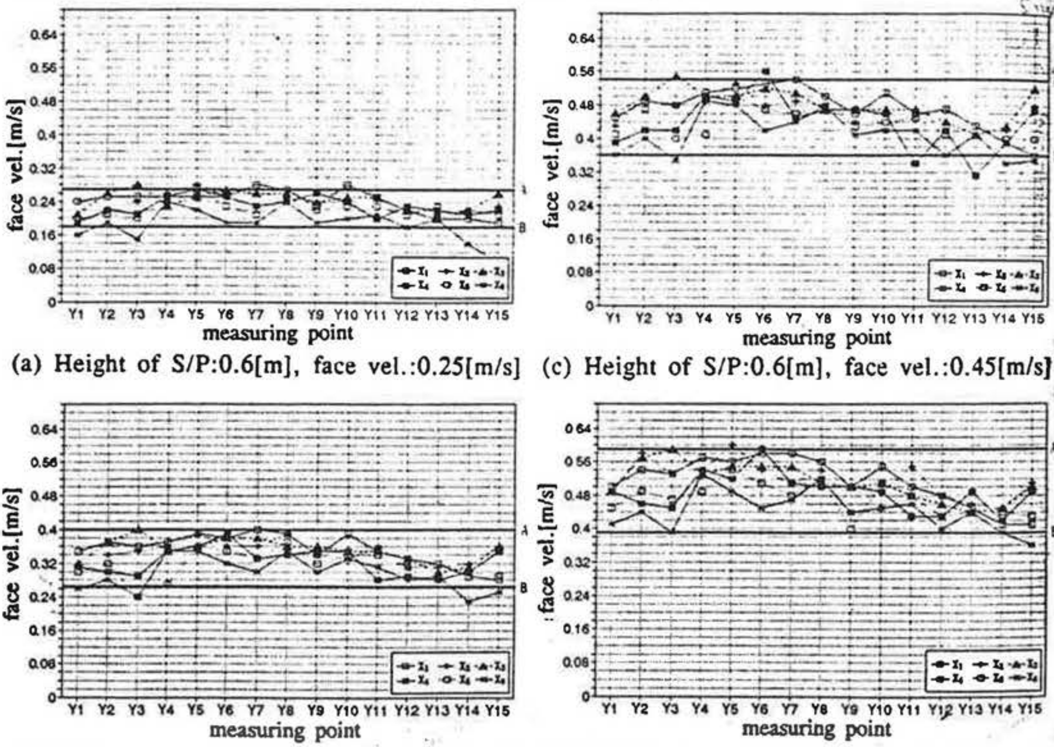
height of supply plenum.

These results show very similiar situation with Figure 4 except at $Y_1 \sim Y_3$ axes. These indicate that face velocity distribution is affected by pressure distribution in supply plenum, though its affection is decreased by pressure loss of HEPA filter. And, the low velocity at $Y_1 \sim Y_3$ axes results from vortex.

3. Estimation of airflow uniformity

Figure 6 shows face velocity distribution at each measuring point in case of 0.6m height of supply plenum. Line A and B direct the range of mean air velocity ± 20% which was suggested by IES for estimating airfolw uniformity.

Table 3 shows the numbers of measuring points satisfying this range except X_1 and X_6



(a) Height of S/P:0.6[m], face vel.:0.25[m/s] (c) Height of S/P:0.6[m], face vel.:0.45[m/s]

(b) Height of S/P:0.6[m], face vel.:0.35[m/s] (d) Height of S/P:0.6[m], face vel.:0.50[m/s]

Fig.6 Face velocity distribution

TABLE 3 Num.of measuring point satisfying mean air vel.± 20% range

HEIGHT OF S/P / FACE VEL.	0.3 m	0.6 m	0.9 m	1.2 m	1.5 m
0.25 m/s	53(88%)	58(96%)	56(93%)	59(98%)	60(100%)
0.35 m/s	58(96%)	59(98%)	58(97%)	58(97%)	56(93%)
0.45 m/s	55(92%)	56(93%)	59(98%)	56(93%)	58(97%)
0.50 m/s	59(98%)	59(98%)	59(98%)	58(97%)	59(98%)

ixes. Measuring points above 88% satisfy this range, and any inclination by the height of supply plenum and supply air volume isn't found.

These are resulted from that though the height of supply plenum is lowered, face velocity varies for the most part within mean air velocity ± 20% range and the range is expanded according to enlargement of supply air volume.

By the way, regressional anaysis was conducted by standard deviation of face velocity.

As a result of experiment, airflow uniformity was up to the state of flux in supply plenum and pressure loss of final filter. So, neck air velocity which represents the state of flux in supply plenum and pressure loss of final filter were adopted for independent variable X_1, X_2 respectively. Standard deviation of face velocity was done for dependent variable Y.

Equation(1) was obtained by regressional analysis in the range showed by hatched area at figure 7. At this analysis, measuring points at X_1, X_6 axes were not considered, because it was thought that they were affected by the wall of supply plenum.

Regressional coefficient was 0.911999.

$$Y = 0.006073\ X_1 + 0.003484\ X_2 \tag{1}$$

where,

Y : standard deviation of face velocity [m/s]

X_1: neck air velocity [m/s]

X_2: pressure loss of final filter [mmAq]

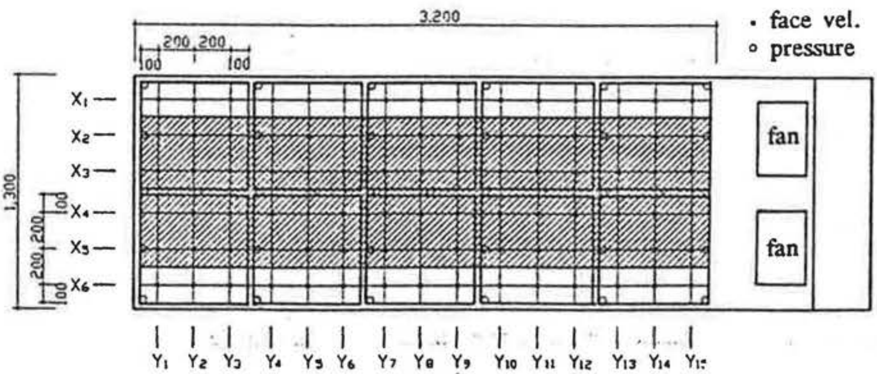


Fig.7 Measuring points for regressional analysis

Equation(2) was obtained by regressional analysis in the range showed by hatched area at figure 8. At this analylsis, measuring points not only X_1, X_2 but also at Y_1, Y_2, Y_3 were not considered, because it was thought that they occupied relatively larger area in this experimental cleanroom than real cases.

Regressional coefficient was 0.90721.

$$Y = 0.006999\ X1 + 0.003141\ X2 \tag{2}$$

where,

Y : standard deviation of face velocity [m/s]

X_1: neck air velocity [m/s]

X_2: pressure loss of final filter [mmAq]

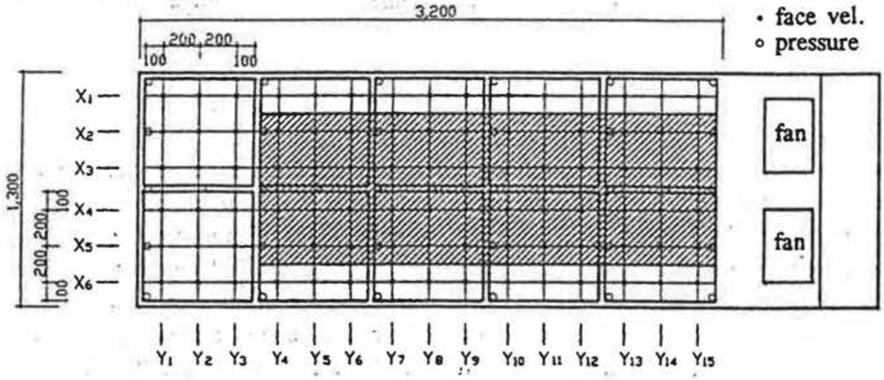


Fig.8 Measuring points for regressional analysis

4. CONCLUSION

Followed conclusion was obtained from experimental results;

1. The state of pressure distribution in supply plenum is up to the height of supply plenum.

2. Stability of pressure distribution in supply plenum is up to supply air volume.

3. Face velocity distribution is affected by the pressure distribution in supply plenum, though its affection is decreased by the pressure loss of filter.

4. Experimental Equation on the correlation between the height of supply plenum, supply air volume and airflow uniformity was obtained by regressional analysis;

① Regressional Equation obtained from hatched area at Figure 7

$$Y = 0.006073\ X_1 + 0.003484\ X_2$$

where,

Y : standard deviation of face velocity [m/s]

X_1: neck air velocity [m/s]

X_2: pressure loss of final filter [mmAq]

② Regressional Equation obtained from hatched area at Figure 8

$$Y = 0.006999\ X_1 + 0.003141\ X_2$$

where,

Y : standard deviation of face velocity [m/s]

X_1: neck air velocity [m/s]

X_2: pressure loss of final filter [mmAq]

For actual application of these Equations, it is needed to simulate by computer in real scale.

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