CHAPTER 10

CALCULATION AND DESIGN DUCT SYSTEM

10.1 GENERAL INTRODUCTION

10.1.1 Duct

Air duct is the device plays the role of connection between the device and the ventilation required space, air duct systems composed of many tubes that connect with each other, with or without branching, duct cross-section can be round, square, rectangular or any of any cross-section.

In the system we can use the fan to make the air movement, there are 2 types of fans are: axial fans and centrifugal fans.

Duct's material is usually metal or zinc thickness from 0.5 to 1.5 mm. The cold air duct is wrapped layers of insulation (outside or inside), outer wrap aluminum to against moisture.

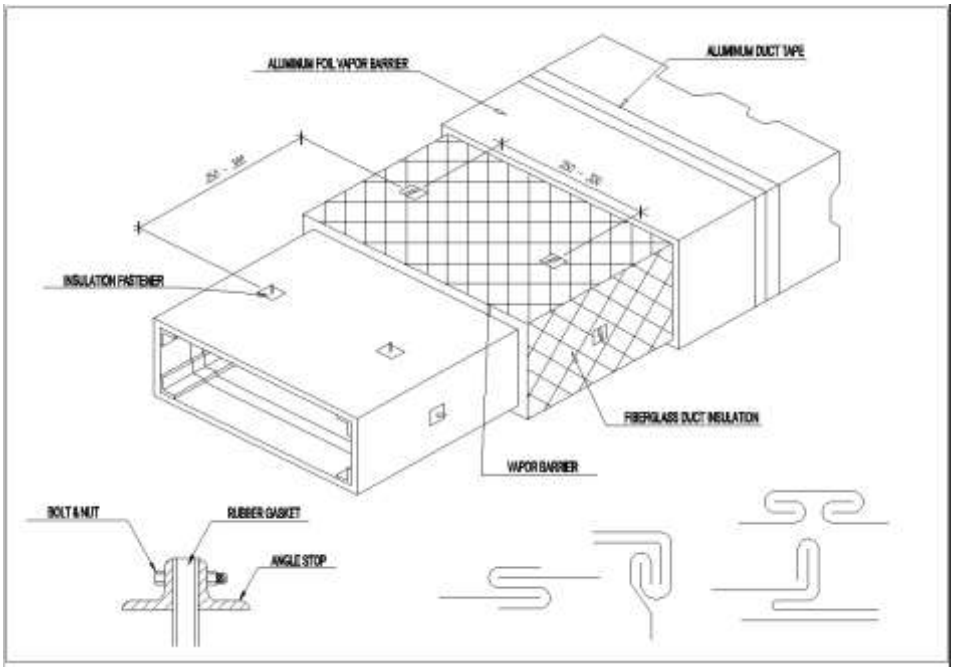


Figure 10.1 *Details of duct structure*

10.1.2 Diffuser, mouth vent

Diffuser is the last device on the duct which has the task of providing and diffuse wind on the conditioning space, distribute all the air in the room. Then the air is taken in through the diffuser to recirculate of air handling equipment.

Diffuser and vents are separated into various categories depending on the shape, the installation location, uses and effects of air distribution, air velocity …

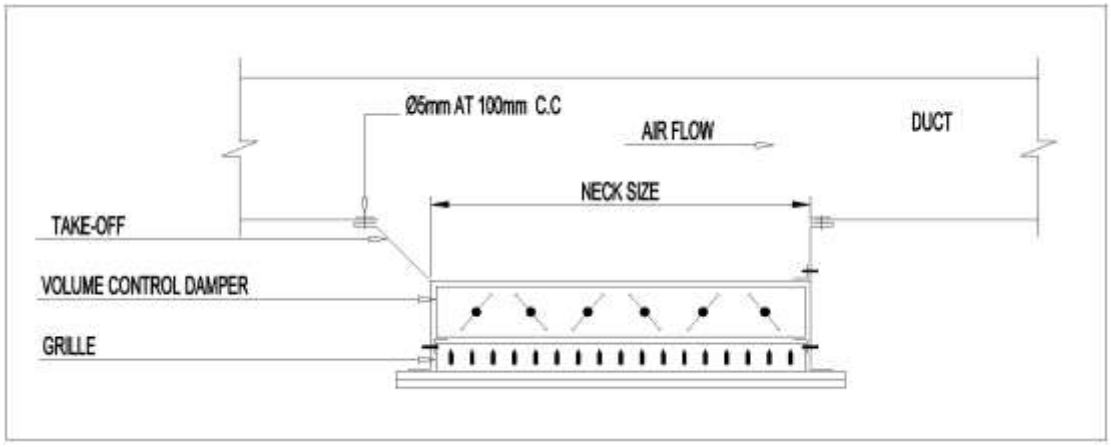


Figure 10.2 *Details of Diffuser air*

10.2 METHODS OF CALCULATION DUCT

10.2.1 Deceleration method

Choose movement speed of the air on the basis of active noise and reduce speed in the next pipe. The design must have practical experience.

Method of implementation:

- Select the speed of the movement of air in the tube before branching.
- Choose reduced speed than the speed at the branch pipe and tube tube next.
- Applicants selected speed and air flow. Each of pipe size.
- On the basis of the flow, speed and pipe sizes we investigate the graph to find the value of the pressure loss.
- Based on the value of the largest pressure loss by a longest path, select the fan.

10.2.2 Equal friction method

Pressure loss per unit length of the tube is the same in the whole system. Suitable for low-speed system, are often used to design tubes, pipes and waste pipes.

Method of implementation:

- Choose the fair value of the pressure loss and retain this value for the entire system, approximately 1Pa for 1m pipe.
- Determine the size of the pipeline on the basis of known traffic in the other points.

10.2.3 Static pressure recovery method

Identify the following pipe sizes for the pressure loss in the pipe right by the increase in static pressure due to the slow movement of the air after each shunts. Requires experience and in the choice of the coefficient data loss. Do not use this method to design the tube.

Method of implementation:

- Choose a reasonable speed for the main pipeline under the table.
- Determine the size of the main pipe.
- The size of the remaining area defined by the graph (in the document).
- The downside of this approach is that the size of the exhaust fan may be larger than normal. Especially for systems with relatively long pipeline.

10.2.4 T method

Optimization method in the design of the newly developed air duct. A special feature of this method is best to pay attention to issues such as: the initial investment costs, operating costs, energy consumption, hours of operation, etc. can be done according to the calculations this by hand, but the calculation is very complex and difficult. Usually done on the computer calculation program.

10.2.5 Method constant speed

The basic content of this method is the selection of one of the most reasonable rate for the entire system. When implementing this method requires the designer to have a lot of experience.

The constant pressure method applied is suitable for high pressure systems. In these systems, before delivering air into the conditioned spaceing is common to use the box (plenum) to decrease speed and noise restrictions.

10.2.6 Method pressure method

Method is modified on the basis of static pressure recovery methods. This method allows the designer to determine the instantaneous total pressure loss in each section of the pipeline system.

Selection method designed wind pipe:

Equal friction method was chosen to design the wind pipe, because this method is suitable for low-speed system of its kind, are commonly used to design tubes, pipes and waste pipes.

For tube type, this method while reducing the speed of movement of the air, which reduces the noise level of the system.

- **SELECT EQUAL FRICTION METHOD BECAUSE :**

We choose uniform friction method to design wind pipeline, because this method is suitable for low speed type systems, which are commonly used to design supply duct, return duct and exshuat duct.

For duct, this method also reduces the air movement speed, which reduces the system noise.

10.3 CALCULATE OF DUCT SYSTEM

*** Select the type of duct:**

In the air conditioning system is the system we use survey pipe air suspension and is covered by a layer of false ceiling.

The material of the pipe is galvanized sheet, outside covered with insulation.

Rectangular cross-section duct elbow for ease of manufacture, the T connector ...

***Duct dimensions:**

For ease of manufacture and assembly, wind ducts are often made into short segments and assembled together by joints.

10.3.1 Calculation of ventilation toilets

Each floor is equipped with a ventilated ducted type fan to meet the air exchange requirements of TCVN 5687-2010, Annex G.

NO	ROOM NAME	Input information			Output information	
		Area m2	Height (m)	Air Change time/h	Exhaust air m3/h	Exhaust air l/s
LIBRARY-1F						
1	WC-Women	13.2	5.25	10	693	194.04
2	WC-Men	13.2	5.25	10	693	194.04
LIBRARY-2F						
3	WC1-Women	20.1	4.025	10	809.03	226.53
4	WC1-Men	20.1	4.025	10	809.03	226.53
6	WC2-Women	14.4	4.025	10	579.60	162.29
7	WC2-Men	18.7	4.025	10	752.68	210.75
8	WC2-Uni	4.3	4.025	10	173.08	48.46
LIBRARY-3F-4F						
9	WC-Women	14.4	5.775	10	831.60	232.85
10	WC-Men	18.7	5.775	10	1079.93	302.38
11	WC-Uni	4.3	5.775	10	248.33	69.53

Table 10.1. *Exhaust air flow for toilets*

Calculating resistance for sanitary ventilation fan:

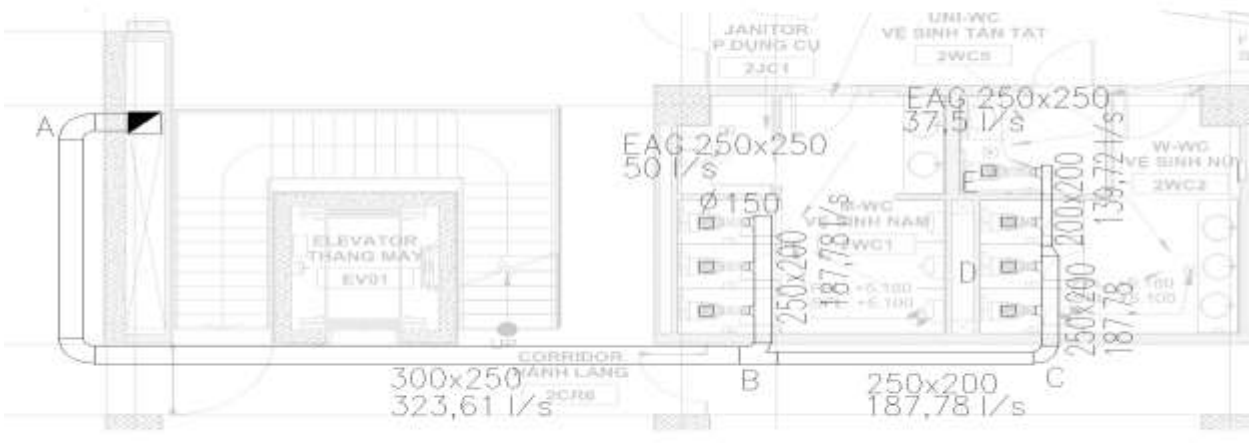


Figure 10.3 Figure 10.3 WC ventilation system WC2-2F-Library

Select the ABCDEG pipeline is the longest pipeline and also the largest impedance pipeline to calculate the fan head pressure.

Calculated by the equal friction method with the loss of 1Pa/m, we get the pipe diameter as follows:

- ED segment: Flow 139,72 l/s, size 200x200.
- DC segment: Flow 187,78 l/s, size 250x200.
- BC segment: Flow 187,78 l/s, size 250x200.
- AB segment: Flow 323,61 l/s, size 300x250.

Choosing the Green Mark EAG with EG-VA size 250x250 with OBD valve, 1.5m/s and 187 m3/h through the grill. Pessura loss: 6 Pa.

Total friction resistance: 23,8m x 1Pa/m = 23,8Pa

Total local resistance:

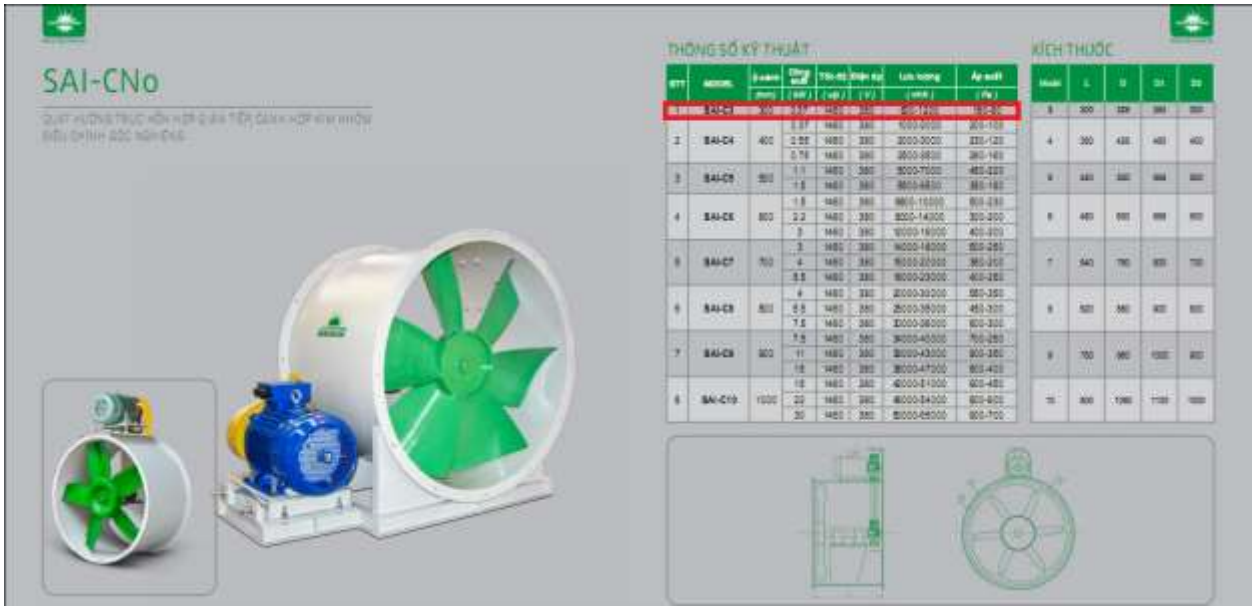
- AB segment: Loss through 1 elbow: 8Pa.
- BC segment: Loss through 1 tee: 6Pa. Loss through 1 elbow: 27Pa.
- CD segment: Loss through 1 reduce: 8Pa. Loss through 2 flexible: 1.5Pa.
- EG segment: Loss through tap: 6Pa. Loss through 2 flexible: 1.5Pa.

Total loss: 88Pa

Select Fantech type axial cleaning fans for each floor:

Flow: 323,61 l/s, Head: 88Pa

We choose the fan System Fan code: SAI-C3 with the following parameters:



10.3.2 Calculation of Fresh air

Each floor is euipped with two axial-type exhaust fans to meet the fresh air supply requirements for people accordimg to TCVN 5687-2010, Annex L.

NO	ROOM NAME	FLOW RATE l/s	DUCT SIZE mm	DUCT SIZE mm	FLUID VELOCITY (m/s)
CENTRAL PLANT-1F					
1	Fire room	345.20	300	300	0.0038
2	Corridor	162.03	250	250	0.0026
3	Server room	2408.18	600	600	0.0066
4	Server room support	524.36	350	350	0.0042
5	Chillers and Pumps room	14620.21	1250	1250	0.0093
6	Corridor	1329.66	500	500	0.0053
7	Fuel Storage Tank	844.56	400	400	0.0052
8	Transformer room	1730.32	550	550	0.0057
9	Medium voltage switchgear room	1668.52	550	550	0.0055
10	Transformer room	1750.92	550	550	0.0057
11	Low voltage switchgear room	1647.92	550	550	0.0054
12	Corridor	54.74	150	150	0.0024
13	Control center	980.75	450	450	0.0048
14	Technical room	456.39	350	350	0.0037
15	Odor treatment room	495.23	350	350	0.0040
CENTRAL PLANT-2F					
16	UPS battery room	288.45	300	300	0.0032
17	Corridor	67.70	200	200	0.0017
18	Server room support	740.28	400	400	0.0046
19	Server room	1464.10	500	500	0.0058
20	Storage	181.44	250	250	0.0029
21	Corridor	200.03	250	250	0.0032
22	Janitor	205.47	250	250	0.0033
23	Corridor-hành lang	236.19	250	250	0.0038
24	Electrical workroom area	586.41	350	350	0.0048
25	Control room	394.81	300	300	0.0044
CENTRAL PLANT-RF					
26	Cooling towers	3507.84	700	700	0.0071
27	Generator room	2346.36	600	600	0.0065

28	Mechanical room	1121.16	450	450	0.0055
29	AHU sever	1290.24	450	450	0.0063
LIBRARY-1F					
30	Conference/Training room	886.58	400	400	0.0055
31	Storage	61.60	150	150	0.0027
32	Janitor	52.80	150	150	0.0023
33	Frist Aid	151.55	250	250	0.0024
34	Aid relaxing room	95.33	200	200	0.0024
35	Storage	97.53	200	200	0.0024
36	Book return room	214.13	250	250	0.0034
37	Corridor	303.11	300	300	0.0033
38	Post room	147.72	250	250	0.0023
39	Storageo/Receiving	149.92	250	250	0.0024
40	Porter room	60.62	150	150	0.0027
41	Uni shop	1260.98	500	500	0.0050
42	Coffee shop	311.42	300	300	0.0034
43	Coffee Storage room	74.55	200	200	0.0019
44	Mechanical room	210.22	200	200	0.0052
45	Elec/tele	52.80	150	150	0.0023
LIBRARY-2F					
46	Journal display/reading	64.31	150	150	0.0028
47	Journal display/reading	64.31	150	150	0.0028
48	Journal display/reading	56.64	150	150	0.0025
49	Journal display/reading	56.64	150	150	0.0025
50	Group Workroom	141.29	250	250	0.0022
51	Group Workroom	141.29	250	250	0.0022
52	Group Workroom	141.29	250	250	0.0022
53	Group Workroom	141.29	250	250	0.0022
54	Storage	43.85	150	150	0.0019
55	Storage	42.39	150	150	0.0019
56	Storage	39.46	150	150	0.0017
57	Prints/Storage	142.51	250	250	0.0023
58	Kitchen/staff lounge	411.68	300	300	0.0045
59	Directors office	163.70	250	250	0.0026
60	Assistants desk	73.08	200	200	0.0018
61	Meeting room	239.70	250	250	0.0038
62	Computer pool	724.41	400	400	0.0045
LIBRARY-3F					
63	Reading theatre	368.65	300	300	0.0041
64	Reading theatre	1651.10	550	550	0.0054

65	Book stacks/Reading room	6068.99	850	850	0.0083
66	Learing room	120.29	200	200	0.0030
67	Learing room	120.29	200	200	0.0030
68	Storage	18.43	100	100	0.0018
69	Copy/print	19.16	100	100	0.0019
70	Group Workroom	101.13	200	200	0.0025
71	Group Workroom	91.50	200	200	0.0023
72	Group Workroom	52.97	150	150	0.0023
73	Group Workroom	52.97	150	150	0.0023
74	Group Workroom	79.46	200	200	0.0020
75	Study carells	445.95	350	350	0.0036
76	Multiedia workroom	384.77	300	300	0.0042
LIBRARY-4F					
77	Book stacks/Reading room	4499.71	750	750	0.0079
78	Reading room	992.28	450	450	0.0049

Table 10.2 *Fresh airflow is provided to personnel.*

Calculating the resistance for fresh air fans to fresh air fans on the second floor of the other floors have the same calculation

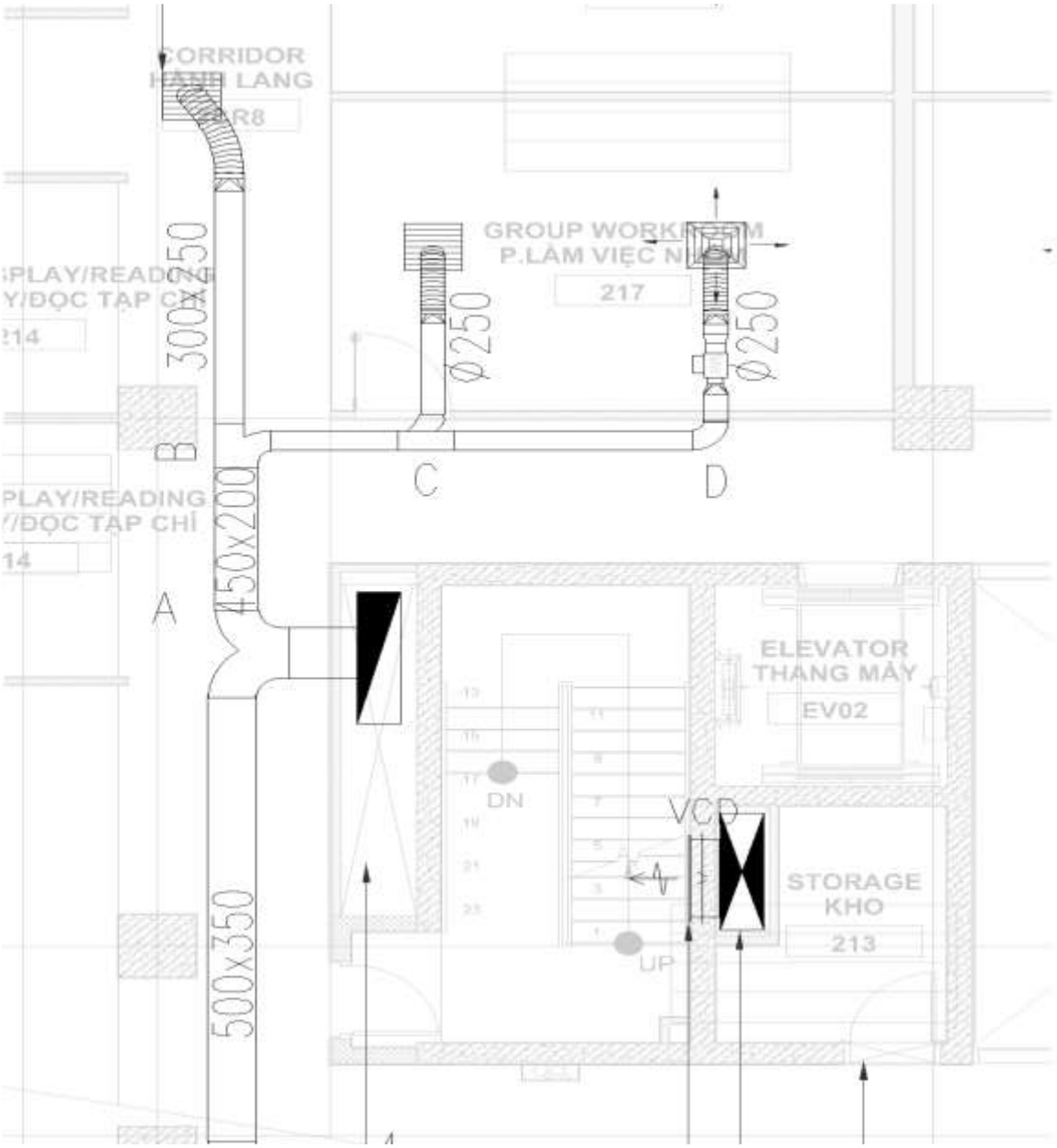


Figure 10.3 *Preliminary alignment of supply fresh air system*

Select the ABCD pipeline is the longest pipeline and also the largest impedance pipeline to calculate the fan head pressure.

Calculated by the equal friction method with the loss of 1Pa/m, we get the pipe diameter as follows:

CD segment: Flow 152,56 l/s, size 250x150

BC segment: Flow 162,12 l/s, size 250x150

AB segment: Flow 392,5 l/s, size 450x200

Choosing the Green Mark EAG with EG-VA size 600x600 with OBD valve, 3m/s and 295 m3/h through the grill. Pessura loss: 8 Pa.

Loss through VCD: 15Pa

Choose silencers of Fantech: 350x350x900 loss 50Pa

Total friction resistance: 12m x 1Pa/m = 12Pa

Total local resistance:

AB segment: Loss through 1 tee at the fan: 6Pa

BC segment: Loss through 1 tee at the fan: 6Pa. Loss through flexible: 2Pa.

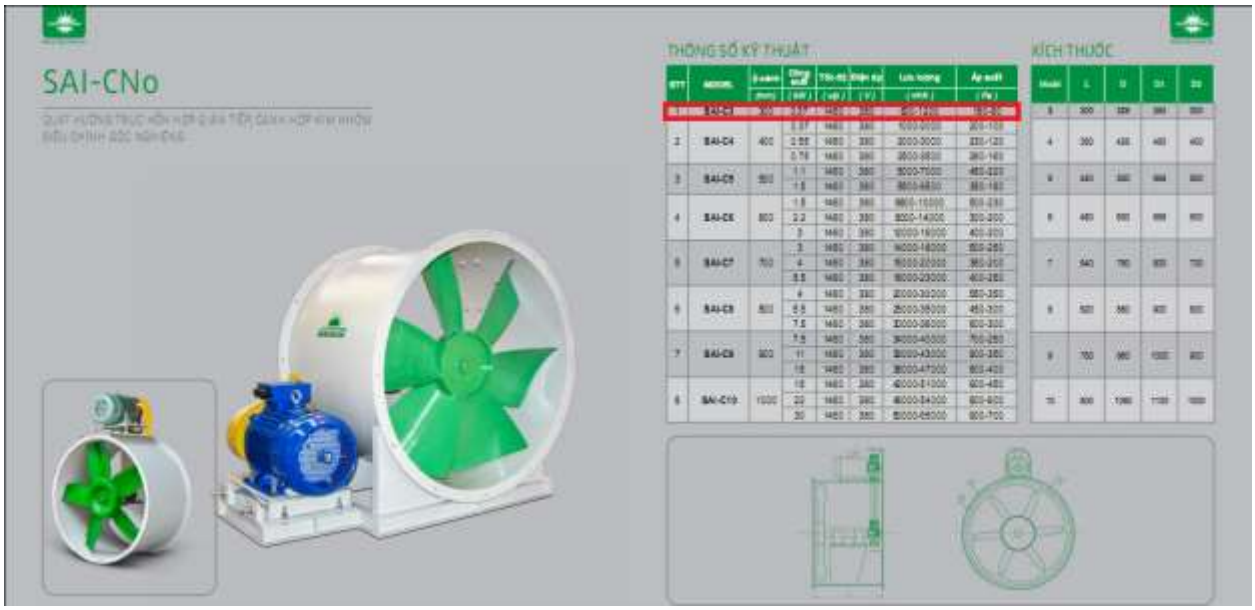
CD segment: Loss through 1 elbow: 15Pa. Loss through flexible: 2Pa.

Select Fantech type axial cleaning fans for each floor:

Flow: 392,5 l/s

Head: 116Pa

We choose the fan System Fan code: SAI-C3 with the following parameters:



10.1.1 Calculation create pressure stairs systems

Because the building has 1 ladder N2 that is non-smoke-free in accordance with QCVN 06:2010/BXD, we need to provide an amount of wind to the elevator's chamber to avoid the intrustion of smoke from outside, to protect the escapees in the elevator's chamber.

Airflow rate to this elevator is calculated as follows:

Airflow through the door when all doors are closed to maintain the pressure difference between the inside of the elevator and the outside is 20~50Pa.

$$Q_1 = 0{,}83 \times A_E \times \Delta P^{1/2} \quad (m^3/s)$$

With:

Q_1 – Airflow through the door (m^3/s)

A_E – Effective leakage area (m^2)

(Following table D1 standard BS 5588-4-1998 page 66.)

m – Total number of doors closed (main)

ΔP – Residual pressure inside the booster chamber (Pa)

(20~50 Pa Following standard VN.5687-2010 and QCVN 06:2010/BXD)

- Airflow rate when opening the opening the emerganecy exit:

$Q_2 = n \times V \times F$ (m^3/s)

n – Number of doors open

(For 3 open doors including 1 exit on the first floor, 1 door onn the fire floor and 1 door on the fire floor)

v – Velocity air through open door(m/s)

(1.3m/s follow standard TCVN.5687-2010 and *QCVN 06:2010/BXD)*

F – Door area (m^2)

We have parameters

n= (3 doors)

$A_E = 0.01 \times 12 + 0{,}02 \times 1 = 0.14$ (m^2)

V = 1.3 (m/s)

$F = 0.8 \times 2.2 = 1.76$ (m^2)

=> $Q_1 = 0.83 \times 0.14 \times 50^{1/2} = 0.82$ (m^3/s)

=> $Q_2 = 3 \times 1.3 \times 1.76 = 6.864$ (m^3/s)

We have the total create pressure stairs systems

$Qt = 120\% \times (Q_1+Q_2) = 120\% \times (0.82 + 6.864) = 9.22$ (m^3/s)

`Calculating resistance for fans creating stairs pressure:

We see that the longest pipe segment from the fan to the blowing mouth on the 1st floor has the largest length and the largest pressure loss, so we conducted the impedance on this segment to calculate the fan pressure column, calculated according to the loss equal friction:

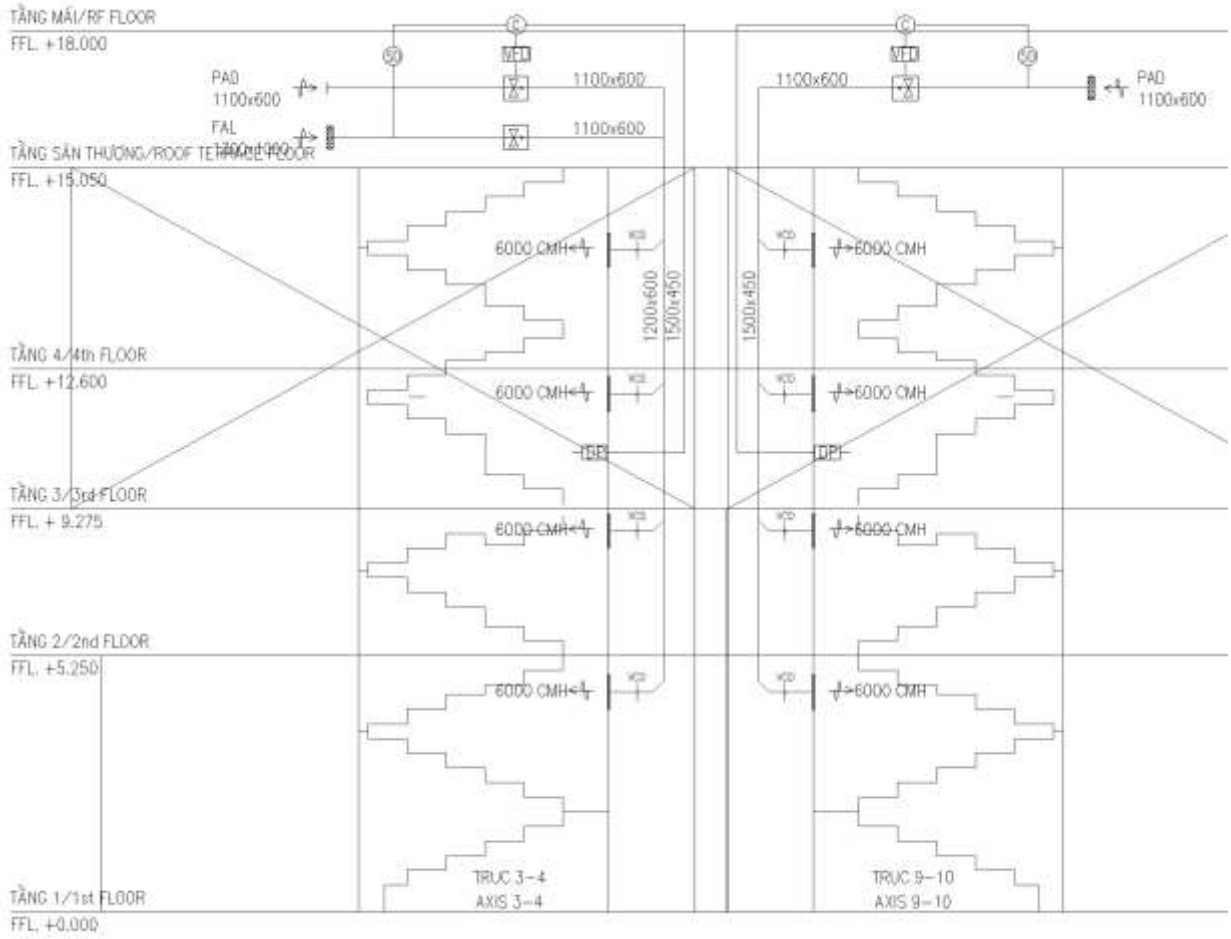


Figure 10.6 *Preliminary alignment of the pressurization system*

NO	ROOM NAME	FLOW RATE l/s	DUCT SIZE mm	DUCT SIZE mm	FLUID VELOCITY (m/s)
1	1F-2F	5438.39	1500	450	0.0081
2	2F-3F	5441.39	1500	450	0.0081
3	3F-4F	5459.44	1500	450	0.0080
4	4F-5F	5472.50	1500	450	0.0080

Table 10.3 *Vertical airflow inlet duct creates pressure*

Choose louver of Reetech firm with free area is 60%, size 550x550+OBD, speed of 5m/s, pressure loss is 60Pa.

Loss through insect screens at fan inlet: 50Pa

- Friction loss in pipe 1 x 15=15Pa
- Localized losses:

Loss through 3 tee: 48Pa

Loss through 1 elbow at 1st floor: 4Pa

Loss through 1 elbow at rooftop: 90Pa

Choose a fan-driven axial pressure type for 22 hours of Fantech brand:

Flow:5472.50 l/s, Head: 285Pa

We choose the fan System Fan code: SAD-C6 with the following parameters: