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Review Article

Calculation of Pressurized Fan Capacity and Static Pressure for Wisma Sudirman Building - Jakarta

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Abstract

Calculation of Pressurized Fan Capacity and Static Pressure for Wisma Sudirman Building – Jakarta. A Pressurized staircase is a significant piece of the fire safety strategy of tall structures. Long departure times are repaid by making safe conditions inside departure staircases permitting considering the uprooting time inside those stairs as time where inhabitants can be viewed as sheltered. In accordance with Minister of Public Works Regulation No: 26/PRT/M/2008 concerning Technical Requirements for Fire Protection Systems in Buildings and the Environment, in every building where the occupied height exceeds 24m, each internal fire stair must be pressurized according to the requirements in the regulation. All pressurization requirements for fire stair in this regulation must comply with the applicable standard provisions in SNI No. 03-6571-2001 or latest edition. The capacity and static pressure of the fire stair fan has been calculated for the Wisma Sudirman building, Jakarta, which obtained a capacity of 34,820 cfm and a static fan head of 2.42 "WG.

Keywords: Pressurized stairs, fan static head.

1. INTRODUCTION

In a high rise building, the stairs usually represent the only way out of the fire. Exit stairs must be smoke-free and to consolidate configuration includes that improves the speed of departure of the inhabitants. The overpressure smoke control method consists of pressurisation by injecting air into spaces which are used as escape routes by people in the case of fire, such as stairwells, corridors, passageways, lifts, etc. This method is based on smoke control by means of the speed of air and the artificial barrier created by the overpressure.

1.1 Management of Smoke

A smoke-the-board system contains all independent strategies or mixing to control or impact smoke production.

The key idea about setting up a smoke management system is to ensure that the evacuation is faster than the spread of smoke / fire. The fire is generally constrained by methods for water pipes, fire hydrants and sprinklers, which ought to be essential for the boarding plan. A procedural fire disguise system will be utilized to restrict the pace of warmth expulsion and Control fire spread:

a. Compartmentation
b. Ventilation of exhaust
c. Dilution
d. Flow of air
e. Pressurization systems

1.2 Movement of Smoke

The structure can be regarded as the progress of space, each space is distributed with a specific weight, and the air between them develops from a high strain area to a low weight area. While by and by, it is workable for compel angles to exist in huge vertical spaces, for example, stairwells, the critical weight contrasts can for the most part be considered as happening over the significant partitions of the structure, for example entryways, windows, dividers and floors. The distinction in weight decides if it will stream by any means, and how much and how rapidly it will stream. Enormous weight contrasts produce huge streams. The chief components liable for the weight contrasts and, subsequently, the smoke development is:

a. Temperature difference between indoor and outdoor air (chimney impact)

b. Common convection
c. Warm extension
d. Wind powers
e. Lightness of burning gases
f. Air conditioning activity

The air movement generated by mechanical ventilation will cause the pressure difference inside the building to be the same as natural forces and superimposed. By designing HVAC system which supplies air at a high rate? HVAC system is becoming now a day more and more popular for buildings. The main advantages of HVAC system limits infiltration of air which caused by winds and stack effects. Improved HVAC equipment can be linked to fire and smoke systems to overcome smoke control duties.

1.3 Classes of Differential Pressure Systems

In accordance with the European standard, there are different classes of differential pressure systems in buildings, depending on their use.

a. Class A System

The conditions are based on assuming that the building will not be evacuated unless it is directly threatened by the fire. The level of compartmentalisation of the fire is normally safe for the occupants who remain inside the building. Therefore it is not very likely that more than one door will be open at the same time in the protected space (either between the stairs and the lobby / corridor or the final exit door).

b. Class B System

A class B differential pressure system may be used to minimise the possibility of serious smoke contamination of the fire control stations during the evacuation of persons and while the fire fighters are extinguishing the fire. During the extinguishing operations, it will be necessary to open the door between the lobby and the living quarters to fight a potentially developed fire.

c. Class C System

Class C systems are designed for all the occupants of the building to be evacuated at once when the fire alarm is activated.

In the case of a simultaneous evacuation, it is assumed that the stairs will be occupied for the normal evacuation period and then be free of people. Thus, the evacuation will take place during the first stages of the fire development, and during this period, it is accepted that a certain volume of smoke may reach the staircase. The air flow contributed by the pressurisation system can eliminate that smoke from the staircase.

It is assumed that during the evacuation, the occupants will remain alert and ready, and be familiar with the area in which they are moving, with the ensuing reduction of the time they remain inside the building.

d. Class D System

Class D systems are designed for buildings where the occupants may be sleeping, for example, hotels, shelters and boarding establishments. The time necessary for the occupants to move in a protected space before reaching the final exit may be longer than that expected in the case of persons who are awake and in good physical condition, and the occupants may not be familiar with the building or need help to reach the final exit / protected space.

e. Class E System

They are used in buildings where fire evacuation is done by phases or as staggered evacuations.

In “evacuation by phases” it is considered that the building would still be occupied for a considerable time while the fire is developing, and so higher fire loads must be considered and hence, a larger volume of smoke and hot gases. (These factors may vary considerable, depending on the type of material in combustion, the fire load generated by them and the load geometry).

In such a situation, the protected staircases must be kept free of smoke to allow the safe evacuation of the people occupying the floors where there is no fire.

f. Class F System

Class F differential pressure systems are used to minimise the possibility of serious smoke contamination of the staircases that are used by fire fighters while the building is being evacuated and while the fire fighters are extinguishing the fire.

During the extinguishing operations, it will be necessary to open the door between the lobby and the living quarters to fight a potentially developed fire.

This system must be designed so that the stairwell and lift shaft (if any) remain free of smoke. If the smoke enters the lobby, the staircase pressure must not lead the smoke to the shaft, and vice versa.

Table 1: Examples use of classes of differential pressure systems in buildings

System Classes	Examples of uses
Class A system:	As a means of escape. On-site protection:
Class B system:	As a means of escape and fire fighting
Class C system:	As a means of escape via simultaneous evacuation
Class D system:	As a means of escape. Risk to persons who are sleeping
Class E system:	As a means of escape with evacuation in phases
Class F system:	Fire protection system and escape means:

2. Regulation and Referenced Standard

2.1 Regulation

a. Minister of Public Works Regulation No. 29/PRT/M/2006 concerning Guidelines for Building Technical Requirements Regarding Technical Requirements for Fire Protection Systems in Buildings and the Environment.

b. Minister of Public Works Regulation No. 26/PRT/M/2008 concerning Guidelines for Building Technical Requirements

c. DKI Regional Government Regulation No. 7 of 2010 concerning Buildings.

d. DKI Regional Government Regulation No. 8 of 2008 concerning the Prevention and Control of Fire Hazards.

2.2 Referenced Standard

a. SNI-03-6571-2001 concerning Fire Smoke Control System in Buildings.

b. SNI-03-6572-2001 concerning Procedures for Designing Ventilation and Air Conditioning Systems.

c. European standard "EN 12101-6 Smoke and heat control systems: Specifications for differential pressure systems

3. Design Criteria

a. Pressurization of fire stairs using a centrifugal fan. The pressure in the fire stair is kept from exceeding 50 Pa, through a measurement of the pressure difference in the stair where a differential pressure controller will increase/ decrease the fan rotation. The pressure fan gets an emergency power source. Electrical cables use fire- resistant cables. Control connected to the MCPFA (main control panel fire alarm) will automatically turn on the fan in the event of a fire.

b. The calculation is based on the number of doors that are open 10% of the number of floors + 1 door (reference: Guidance from TPIB-DKI).

c. All the systems must be designed so that the force to be applied to the door handle to open it does not exceed 100N.

4. Calculation

4.1 Capacity Calculation

Firestair door data:

- Length = 6.10 ft
- Width = 2.80 ft
- Gap width = 10 mm

a. The building is 52 floors; the number of fire doors that must be open during a fire is 10% of the number of floors + 1 = 6 floors.

b. Firestair door area = (6.10 x 2.80) ft2
=17,08 ft2

c. Air flow velocity through opened door 1.0 – 1.5 m/s or (197 fpm – 295 fpm), the velocitity for this calculation is taken 250 fpm.

d. Air flow for 6 opened doors

Qs = 6 x 17.08 ft2 x 250 fpm
= 25,650 cfm (ft3/min)

e. Infiltration flow flow 46 closed doors

Qy = 46 x 200 cfm
= 9200 cfm

f. Total air flow

Qt = Qs + Qy
= 25,650 cfm + 9,200 cfm
= 34,820 cfm

The pressure difference between the fire stair and the room behind it is taken to be 0.2 "WG (50 Pa) when the door is fully closed, and 0.06 "WG - 0.1 "WG (15 - 25 Pa) when 3 doors are fully opened. The temperature is taken mean air = 89.5 F (32 C).

4.2 Static Pressure Calculation

a. Pressure drop data

- Pressure drop for each oulet grille c/w volume damper = 0.15 "WG
- Pressure drop for ducting (length = 16.4 ft)
= 0.2 "WG/ 100 ft
- Pressure drop for inlet fan
= 0,1 "WG

b. Pressure drop for vertical ducting

Total bulding height = 256.5 m
≈ 841.32 ft

Pressure drop $= \frac{0.2\ "WG}{100\ ft}$ x 841.32 m
= 1.68 "WG

c. Pressure drop for horizontal ducting

Ducting length = 16.4 ft

Pressure drop $= \frac{0.2\ "WG}{100\ ft}$ x 16.4 m
= 0,0328 "WG
= 0.04 "WG

Pressure drop for elbow/ bending

Velocity pressure = 0.316 "WG
Fitting loss coefficient = 0.08

Pressure loss for 1 (one) elbow = 0.316 “WG x 0.08
= 0.025 “WG

Pressure drop for 2 (two) elbow = 2 x 0.025 “WG
= 0.05 “WG

d. Pressure drop for volume damper
1 (one) volume damper = 0.051 “WG

e. Pressure drop for oulet grille
1 (one) outlet grille = 0.1 “WG

f. Pressure drop for inlet fan (wire mesh)
1 (one) inlet fan = 0.1 “WG

Total pressure drop = 2.02 “WG, with safety factor 1.2
With safety factor for design 1.2,
Static pressure for pressurized fan = 1.2 x 2.02 “WG
= 2.42 “WG

4.3 Fan Power

Capacity(V) =. 34,820 cfm
Static pressure (sp) = 2.42 “WG
Efficiency (γ) = 60%
constanta (f) = 0.000157
Safety factor (sf) = 1.2

$$HP = \frac{V x sp x f x sf}{\gamma}$$

$$= \frac{34{,}820 x 2.42 x 0.000157 x 1.2}{0.6}$$

=26.50
= 30 kW (Power rated)

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- Salah Uddin Aubby, Dr. Mohammed Mohsin Ali H., Staircase Pressurization System.
- Sodeca, Pressurisation Control Systems For Staircases, Fire-Fighting Lobbies And Escape Routes.