UDC: 691.32

AIR DISTRIBUTION BY VENTILATION AND AIR CONDITIONING SYSTEMS IN CIVIL BUILDINGS BY CEILING FAN JETS

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In order to ensure the normalized meteorological conditions in the premises of the administrative buildings according to the required allowable or optimal parameters of the indoor environment in the served area of the premises, a good organization of air exchange with correct air distribution can be sufficient [1]. In this process, one of the most important aspects of ventilation and air conditioning systems is the accurate design calculation of airflow rates, the correct assignment of airflow patterns in the room volume and the correct selection of air distributors. The air flow rate per room can be determined based on the multiplicity of air exchange rates for the room for its purpose and area, or by compiling a balance of priority harm and air balance. Selection of air distribution devices and their location in the room depends on the purpose and size of the room, combination of types of harmful emissions, requirements for the air environment, placement of equipment and workplaces in the room and other conditions [2] .

To date, theory and practice recommend many [3] types of air diffusers and some of them ceiling air diffusers (plafonds) producing fan jets (fig. 1).

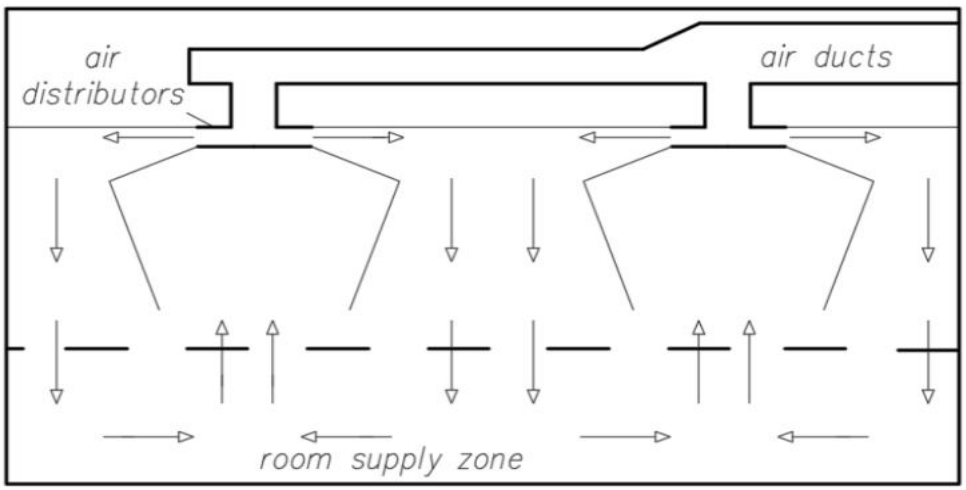

Figure 1. Air distribution scheme with ceiling diffusers

When organizing ventilation systems, the structural design of the building must be taken into account. The correct solution of ventilation determines the convenience of installation and operation of ventilation systems, the availability of the system for repairs, good appearance of the room and, most importantly, high efficiency of air exchange. The issue of air supply and disposal depends on the specific conditions.

As an example, the system of air conditioning of fitness center gyms with ceiling air diffusers is considered. These are definitely three gyms located on the top floor of the fitness centre with exercise equipment and stained glass windows (fig. 2). Given that this is a room where there can be a large number of people and they are engaged in physical exercise, releasing into the environment of the room heat, moisture and the product of breath - carbon dioxide, there is an imbalance of these hazards. Factors that affect the moisture and heat balance in this case. In the cold season it is - heat supply, moisture supply by people, heat supply of equipment, heat loss to the outside environment, through outdoor structures, and heat supply from heating devices of the heating system. In the warm season - heat, moisture from people, heat from electrical equipment, solar radiation entering the room through the windows and roof. In order to normalise and create a good microclimate in such rooms, the moisture and heat balance is determined (table 1).

Table 1 Moisture and Heat Balance, kJ/h and kg/h

Season of year	Thermal power of solar radiation		Thermal power of the illuminator-equipment-blowing	Thermal flux emitted by people	Thermal power of the heating system	Thermal flow lost from the room	Excess heat	Excess moisture
	across the windows	across the roof						
1	2	3	4	5	6	7	8	9
Summer	42452,5	8658,6	23020,8	43712,3	-	-	117844,1	10,56
Winter	-	-	23020,8	42958,6	-	-	65979,4	8,94

Based on the data obtained (table 1), the engineering method of calculation determines the mass flow rate of the inflow air G and the volume flow into the room L (table 2).

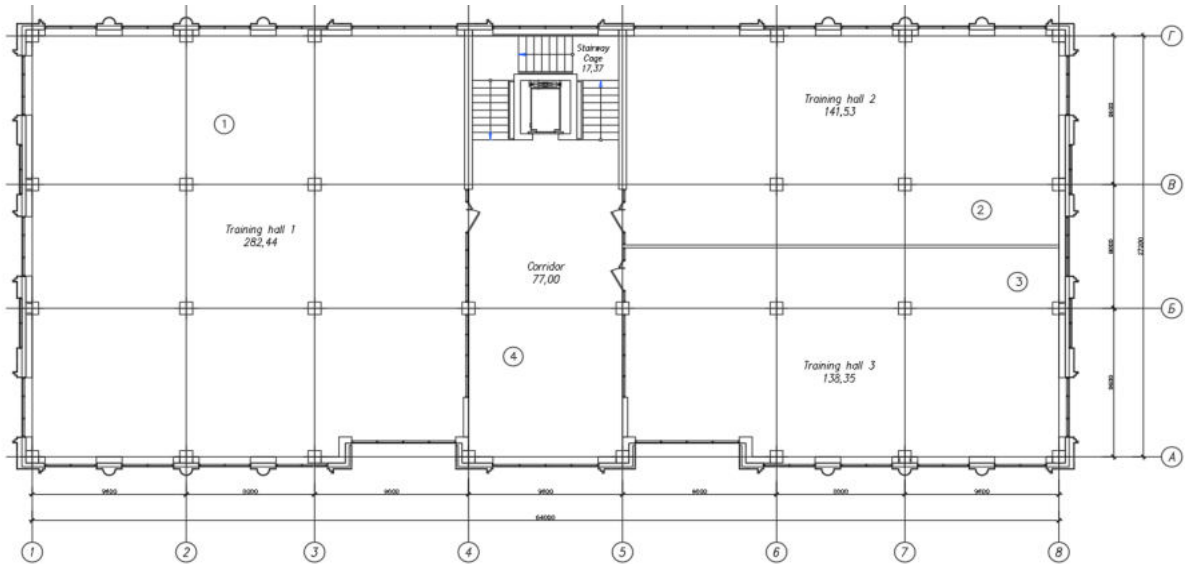

Figure 2. Training hall plan

Table 2.Supply air expenses

Name of room	Area, м^2	G, kg/h	L, м^3/h
Training hall 1	282,44	8289,37	6907,81
Training hall 2	141,53	4153,78	3461,49
Training hall 3	138,35	4060,45	3383,71
Corridor	77	2259,88	1883,24

When the air flow rate for each training hall is known, you can determine the number of air diffusers. When selecting air diffusers, it is important to consider the supply air movement. To ensure a good microclimate for people in the training halls, respectively, it is necessary to eliminate the feeling of blowing air, because with a smooth distribution of air-ha, the person does not feel the fresh air supplied, which contributes to good health. Such an opportunity is given to us by the ceiling water distributor, which has a flat plate twice the size of the supply pipe. The jet attacking it will change direction and spread in all directions along the radius, such jets are called fan jets (fig. 4). The jet width increases rapidly as it moves away from the supply opening, resulting in a sharp drop in speed and an intensive change in temperature and hazard concentrations. This supply air principle is used to eliminate the feeling of blowing at high air velocities [2, 3]. Therefore, in the case under discussion, the preferred method of air distribution is by ceiling mounted air diffusers.

When calculating the ceiling air diffuser, special instructions regarding the use of the maximum permitted air velocity and the diameter of the supply spigot must be followed [1,2,3]. Place air diffusers not closer than 10-20 diameters of necks between them at the intersection of diagonals of squares or rectangles in a ratio of 3:2. Following the instructions for air flow rates, the number of air diffusers is determined using the following formula:

$$P = \frac{L}{2820 * \vartheta * d^2}$$

Где, L – room air requirement, m^3/h; ϑ – air speed, м/с, $\vartheta = 3 \div 5$ m/s; d – diameter of the neck, m.

The diameters of the air diffuser necks are taken according to the data [3]. According to air consumption, diameters were taken in each gym: hall 1 – 350mm, hall 2, 3 and corridor – 250mm (fig. 3). The results are shown in table 3.

Table 3. Number of air diffusers

Name of room	Area, m^2	G, kg/h	L, m^3/h	P	Air speed, m/s
Training hall 1	282,44	8289,37	6907,81	6	4,00
Training hall 2	141,53	4153,78	3461,49	5	4,00
Training hall 3	138,35	4060,45	3383,71	5	4,00
Corridor	77	2259,88	1883,24	3	4,00

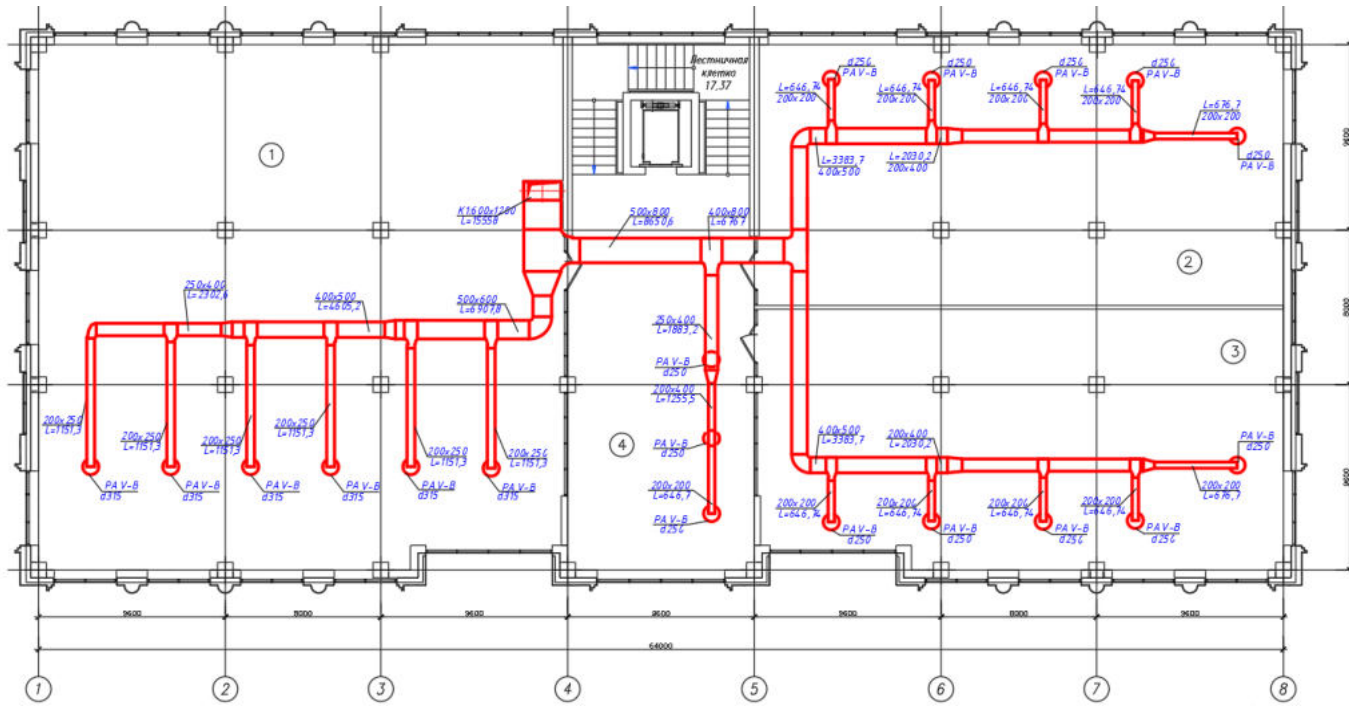

Fig. 3 Plan of a training hall with a supply air conditioning system

The number of air diffusers was found and placed according to the instructions (Fig. 3). It should be noted that it is advisable to provide for a fume hood from the lower parts of the room. If the hood is considered in the upper area of the room, it is recommended to make the distance between the hood and the inflow 6d, at shorter distances should be lower than the ceiling at a distance of 0.6d.

Fig. 4 Ceiling diffuser

Conclusion. In volumetric rooms with physically active people, ceiling air diffusers are effective, which spread clean supply air by means of a fan stream. The air that is supplied at high speed when colliding with the shield gradually reduces the speed and temperature, forming a smooth movement of air, which has a favorable effect on human well-being and, of course, better blowing effect. When choosing ceiling-mounted air diffusers, clear instructions for their use should be followed, otherwise the air exchange in the room will be unsatisfactory.

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