ook Supply Bureau Under the License from BIS for LARSEN AND TOUBRO CONSTRUCTION - MANAPAKKAM, CHENNAI ON 17-03-2017 09:00:59 (123.63.24.35) valid up

11.5 Underground Car Park Ventilation

11.5.1 *Requirement*

Ventilation is essential in enclosed car parking areas to dilute the level of toxic gases such as carbon monoxide (CO), oxides of nitrogen (NOx), presence of petrol/diesel fumes and smoke from engine exhaust. Carbon monoxide is a colourless, odourless and highly poisonous gas. Even dilute concentrations of CO in air can cause nausea, headache and vertigo. The undesirable health and fire hazard of the above contaminants can be contained if their levels are maintained within permissible limits by ventilation.

The ventilation rate required to maintain the concentration of toxic gases within safe limits for an enclosed parking facility depends primarily on four factors:

a) Numbers of cars in operation during peak usage (N),

b) *Length of time of operation* — The length of time a car remains in operation in a parking garage (T_m),which further depends on the size and layout of the garage and the number of cars trying to enter or exit. The time taken can vary from 60 s to 600 s, but on average ranges from 60 s to 180 s.

c) *Car emission rate* — The operation of a car in a parking garage differs considerably as compared to the car on the road or even in a road tunnel, because most of the operation of the car in and around the garage takes place at low gear. A car entering the garage is at slow speed but the engine is usually hot. A car exiting the garage has a cold engine with rich fuel mixture. Emissions from a cold start are generally much higher, so the distinction between a hot and cold start plays a critical role in determining the ventilation rate. Typical CO emissions (E) within parking garages can vary from 113 g/h (gram/hour) in summers to 202 g/h in extreme winters with hot engines. With cold start engines, the rates go up to 220 g/h in summers to as high as 1 130 g/h in winters. These rates are at an assumed vehicle speed of 8 km/h.

d) *Contaminant level criteria* — The recommended ventilation rate will ensure that the CO level is maintained within 40 mg/m^3 (35 ppm) for 1 h exposure, with a maximum of 29 mg/m^3 (25 ppm) for an 8 h exposure.

For a maximum permissible CO concentration of 29 mg/m^3, the required ventilation rate, Q, in m^3/h, for a given car park with number of cars in peak usage, N, may be calculated from the following equation:

$$Q = \frac{0.25N \times E \times T_m}{26.7}$$

where

N = number of cars in peak usage;

E = average CO emission per car, in g/h; and

T_m = average time a car remains operating in the car park, in s.

For a parking garage of area, A, in m^2, and height, H, in m, the resulting air changes per hour (ACPH) may be calculated as under:

$$ACPH = \frac{Q}{(A \times H)}$$

11.5.2 *Ventilation Rate Requirement of Mechanically Ventilated Underground Car Parks*

For enclosed underground car parks without provision for natural ventilation, a minimum ventilation rate of 6 air changes per hour shall be provided to keep contaminants within acceptable hygiene limits. In large basements, each compartment shall be independently ventilated at the minimum rate of 6 ACPH.

11.5.3 *System Requirement*

The underground car park ventilation system can be classified as supply-only, exhaust-only or a combination of the two. A system of ducts or impulse fans (jet fans) may also be used for proper distribution of air in the car park. Regardless of which system is used, the following elements should be considered in planning the system:

a) Accounting for the contaminant level of outside air drawn in for ventilation.

b) Avoiding short circuiting supply air.

c) Avoiding a long flow field that allows contaminants to exceed acceptable levels at the end of the flow field.

d) Providing short flow fields in areas of high contaminant emission, thereby limiting the extent of mixing.

e) Providing efficient, adequate airflow throughout the structure.

f) Accounting for stratification of engine exhaust gases when stationary cars are running in enclosed facilities, for example near entry and exit.

For underground car parking, the fans and the ventilation system used for normal CO level ventilation are also used for smoke ventilation during a fire. The extraction fans, ancillaries and the system should therefore be rated for high temperature operation including air changes per hour requirement, as specified in Part 4 'Fire and Life Safety' of the Code.

Supplied by Book Supply Bureau Under the License from BIS for LARSEN AND TOUBRO CONSTRUCTION - MANAPAKKAM, CHENNAI ON 17-03-2017 09:00:59 (123.63.24.35) valid upto31-12-2016