International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 5 Issue 4 || April 2016 || PP 73-77

Assessment of Ambient Carbon Monoxide Levels along Bahadur Shah Zafar Marg, New Delhi, India

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Abstract: *Vehicular emissions are a dominant source of carbon monoxide (CO) in urban environments, with light-duty gasoline-powered vehicles contributing the largest share. Carbon monoxide is primarily generated due to incomplete combustion of fossil fuels during road traffic operations. Numerous investigations have focused on monitoring and estimating CO concentrations because of its toxic nature and widespread presence in urban air. Given the seriousness of this issue, systematic assessment of CO levels in high-traffic corridors is essential. In the present study, hourly variations of ambient CO concentrations were monitored at selected urban roadway locations along Bahadur Shah Zafar Marg, New Delhi. Measurements were conducted between 8:00 AM and 8:00 PM using a portable real-time CO monitoring instrument. The analysis of average hourly concentrations revealed a distinct bimodal pattern, with elevated CO levels occurring during morning and evening traffic peak periods. The findings highlight the strong influence of traffic intensity and roadway environment on ambient CO concentrations.*
Keywords: *Carbon monoxide, Vehicular emissions, Urban roads, Air quality monitoring*

I. Introduction

Carbon monoxide (CO) is one of the most significant pollutants emitted by motor vehicles, particularly from gasoline-fueled light-duty vehicles. In urban areas, road traffic is recognized as a major contributor to air pollution and poses serious risks to human health. Several studies have identified urban transportation systems as a primary source of atmospheric pollutants, leading to adverse respiratory and cardiovascular effects. CO is formed as a result of incomplete combustion in vehicle engines and is commonly used as an indicator pollutant to represent traffic-related air contamination.

Unlike many reactive pollutants, CO remains relatively stable in the near-road environment, making it a useful tracer for understanding the dispersion and transport of primary vehicular emissions. Continuous or prolonged exposure to CO, even at relatively low concentrations, can cause symptoms such as headaches, dizziness, nausea, impaired cognitive function, and in severe cases, cardiovascular complications. Long-term exposure has also been linked to increased risks of atherosclerosis and heightened vulnerability among individuals with pre-existing heart disease and pregnant women.

Previous research has reported that motor vehicles contribute more than 90% of CO emissions in many urban areas. Rapid growth in vehicle ownership, particularly in developing countries, has intensified concerns related to traffic-generated air pollution. Numerous monitoring and modeling studies have examined CO concentrations near roadways and intersections in cities worldwide. However, localized assessments remain crucial due to variations in traffic composition, road geometry, and surrounding built environments. The present study aims to investigate the temporal variation of average hourly CO concentrations at selected monitoring locations along Bahadur Shah Zafar Marg in New Delhi, India.

II. Materials And Methods

The methodology adopted for this assessment includes selection of monitoring sites, description of sampling locations, monitoring equipment, data collection procedures, and data analysis techniques.

2.1 Site Selection

Bahadur Shah Zafar Marg was selected for this study due to its high traffic volume, mixed traffic composition, and typical urban roadway characteristics. The road corridor is flanked by buildings of varying heights, widths, and architectural forms, which influence pollutant dispersion. Four monitoring locations were identified along this roadway:

- **Delhi Gate side:** Monitoring Locations 1 and 2
- **India Gate side:** Monitoring Locations 3 and 4

All monitoring sites were positioned approximately 150 meters away from the main roadway intersection to capture representative traffic-related CO concentrations.

2.2 Carbon Monoxide Monitoring Equipment

Ambient CO concentrations were measured using a portable carbon monoxide detector (Model CO–84). The instrument operates on an electrochemical sensing principle, where ambient air diffuses through a perforated cap and interacts with the sensor cell. The device provides real-time CO concentration readings and is capable of detecting CO levels ranging from 0.1 ppm to 99 ppm. Its portability and sensitivity make it suitable for on-site urban air quality monitoring.

2.3 Monitoring Procedure

CO monitoring was conducted at each selected location from 8:00 AM to 8:00 PM using the portable online CO detector. Prior to field deployment, the instrument was calibrated according to standard procedures. Since the device did not include an automated data logging system, CO readings were manually recorded at 3-minute intervals.

For the **Delhi Gate side locations (1 and 2)**, monitoring was carried out between April 3 and April 18, 2011. A total of 242 observations were collected at each location.

For the **India Gate side locations (3 and 4)**, monitoring was conducted from March 2 to March 17, 2011, with an identical number of observations per site.

The recorded data were processed to calculate average 1-hour and 8-hour CO concentration values for each monitoring location.

2.4 Data Analysis

The collected CO concentration data were averaged over one-hour intervals to obtain hourly mean values. Subsequently, these hourly averages were further aggregated to determine 8-hour average concentrations. Temporal variations in CO levels across the four monitoring locations were analyzed using spreadsheet-based statistical tools.

III. Results And Discussion

This section presents and discusses the temporal variation of average hourly CO concentrations at the selected urban road locations during the monitoring period (March–May 2011). The monitored concentrations were also evaluated against prescribed air quality standards.

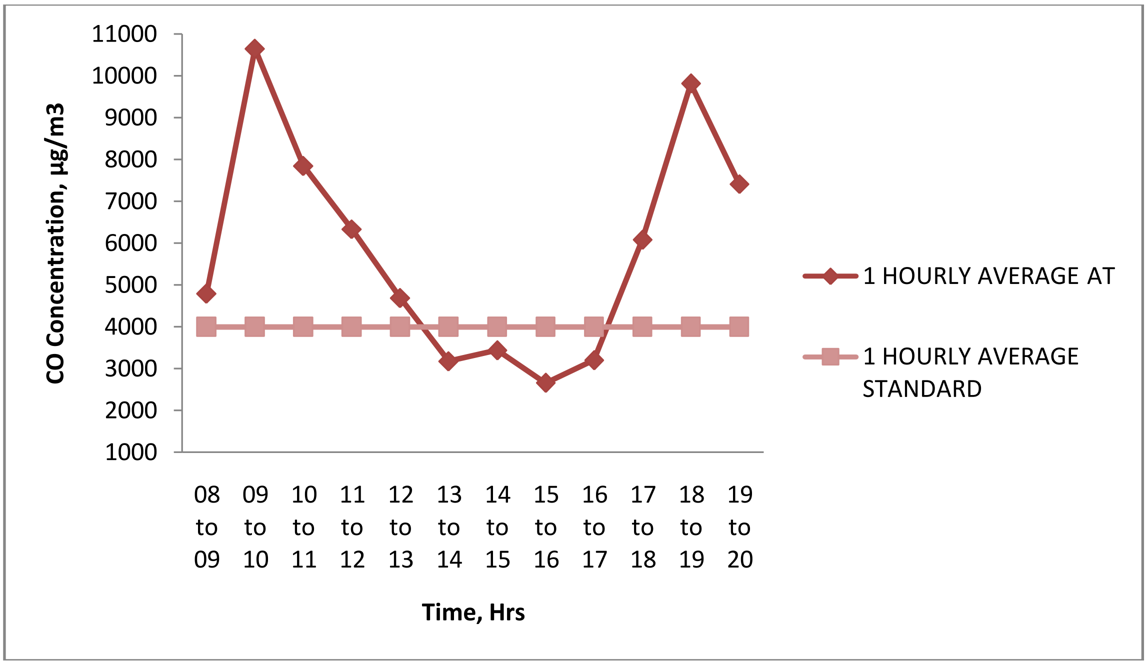

Fig.: Average hourly concentration of CO at location 1

3.1 CO Levels at Bahadur Shah Zafar Marg (Delhi Gate Side)

At monitoring Locations 1 and 2, the average hourly CO concentrations exhibited a clear bimodal pattern characterized by morning and evening peaks. This trend was consistently observed throughout the monitoring period.

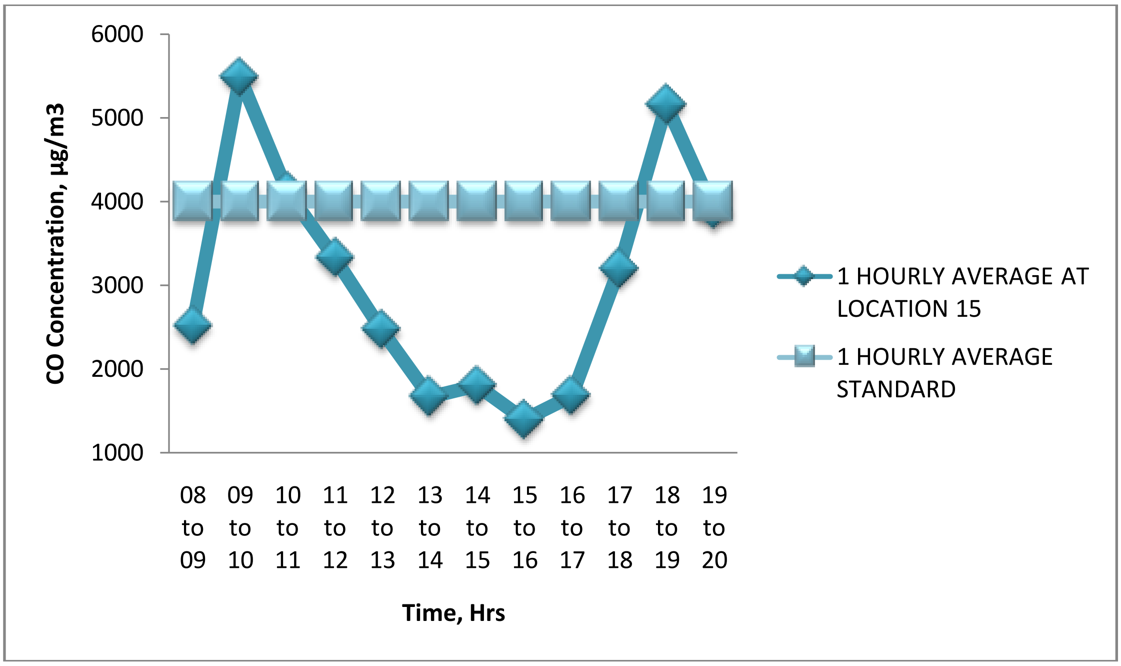

Fig.: Average hourly concentration of CO at location 2

At **Location 1**, situated near the INSA Building, the highest 1-hour average CO concentration reached **10,649 µg/m³** during the morning peak (9:00–10:00 AM), while an evening peak value of **9,817 µg/m³** was observed between 6:00 and 7:00 PM. These values significantly exceeded the prescribed permissible limit of **4,000 µg/m³** for 1-hour average CO concentration.

At **Location 2**, near the Police Headquarters, the peak 1-hour average CO concentration was recorded as **5,490 µg/m³** in the morning and **5,157 µg/m³** in the evening. These concentrations also exceeded regulatory limits. Additionally, 8-hour average CO concentrations at both locations were found to be substantially higher than the allowable standards.

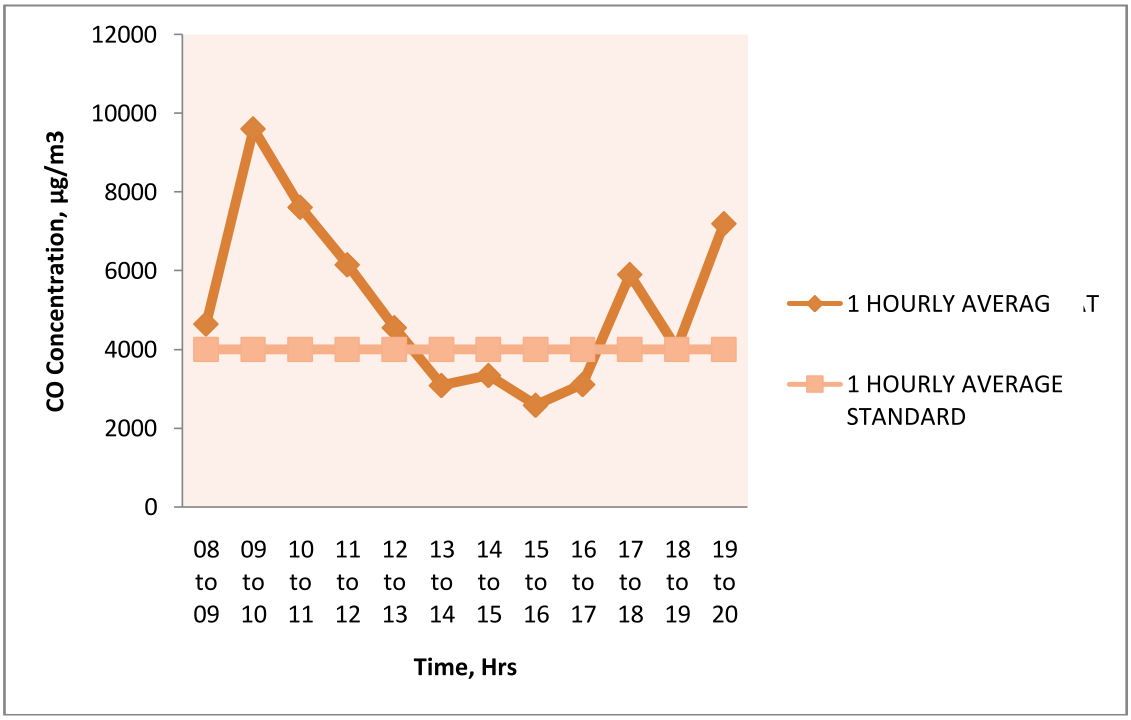

Fig.: Average hourly concentration of CO at location 3

3.2 CO Levels at Bahadur Shah Zafar Marg (India Gate Side)

Monitoring results from Locations 3 and 4 similarly revealed elevated CO concentrations during traffic peak hours. At **Location 3**, adjacent to the Institution of Engineers building, the maximum 1-hour average CO concentration was observed to be **9,604 µg/m³** during the morning peak and **7,195 µg/m³** during the evening peak.

At **Location 4**, near the Andhra School building, the peak 1-hour average CO concentrations were **3,938 µg/m³** in the morning and **4,216 µg/m³** in the evening. While morning values were slightly below the standard, evening concentrations exceeded permissible limits. The 8-hour average CO concentration at Location 3 was significantly above the prescribed limit, whereas Location 4 showed marginal exceedance.

The differences in CO levels among locations may be attributed to variations in building configuration, road ventilation, and pollutant dispersion characteristics.

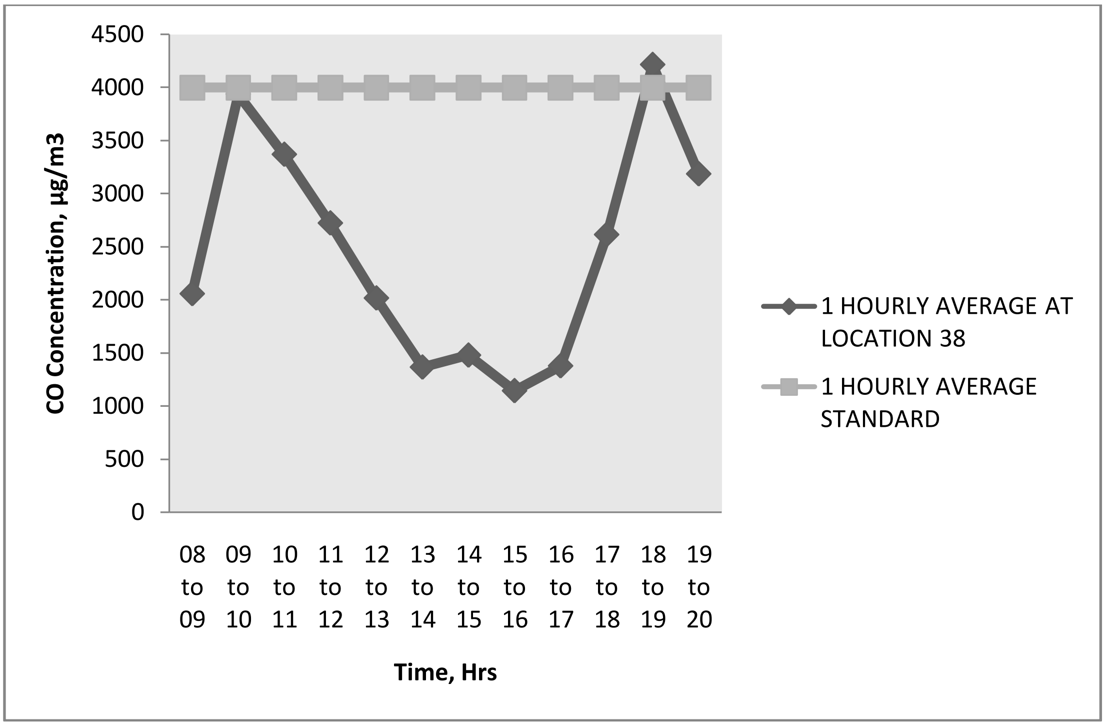

Fig.: Average hourly concentration of CO at location 4

IV. Conclusions

The monitoring results demonstrate that ambient CO concentrations along Bahadur Shah Zafar Marg consistently exhibit two distinct peaks corresponding to morning and evening traffic rush hours. Both 1-hour and 8-hour average CO concentrations at most monitoring locations exceeded prescribed air quality standards, indicating non-compliance and potential health risks.

Spatial variation in CO concentrations was observed across different roadway approaches, with higher concentrations generally recorded near high-rise buildings where pollutant dispersion is restricted. Conversely, lower concentrations were observed in areas with open spaces or low-rise structures, likely due to enhanced dispersion and dilution. The findings underscore the influence of urban built form on near-road air quality and highlight the need for targeted mitigation measures in high-traffic corridors.

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