Comparison of air-borne Particle size Distribution between Freeways and Intersections: A Case Study of NH-32, Dhanbad, India

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Abstract: Dhanbad district of Jharkhand state is designated as the "coal capital of India". Being an important city, Dhanbad experiences a huge flow of daily traffic and hence increased level of pollutant load, especially at occupational areas. Most of these occupational sites are located beside (mostly at intersections) NH-32 (National Highway) as it is the most important roadway of Dhanbad. Air quality of this area affects a large portion of the entire population of the city. Particulate matters, as they are the most potential hazard in ambient air, are the major subject of concern for this study. The degree of harmfulness depends on the size of particulates: lesser the size, greater the threat. This study quantifies 31 classes of particulate size to estimate the particulate load. Two intersections and two freeway sites, were monitored for measuring particulate concentration. Another site, away from the roadways, was taken as control site for background concentration measurement. It was seen that finer particle concentration is more at intersections compared to freeways and larger particles are more concentrated at freeways compared to intersections. Highest pollutant concentration of finest particulates was found at Govindpur, where two national highways (NH-32 and NH-2) intersect. Both of the freeway sites exhibit higher concentration values for PM_{10} and $PM_{2.5}$ than that of the intersections. All sampling sites including the control show concentration values higher than both NAAQS (National Ambient Air Quality Standard) and CPCB (Central Pollution Control Board) standards in case of $PM_{2.5}$. All monitoring locations except the control site demonstrated higher level of PM_{10} than its NAAQS and CPCB standards. This study may help the regulatory bodies to take appropriate measures to minimize the exposure of particulates to the public.

Keywords: PM_{10}, $PM_{2.5}$, Particle size distribution, Ambient air quality, Vehicular pollution, Intersection, Freeway, Dhanbad.

1. INTRODUCTION

Dhanbad is known as the "coal capital of India" for its rich deposits of coal. It has a number of coal mines and associated industries [1]. Besides this, many washeries, thermal power plants, hydro power plants and other commercial establishments make this city one of the busiest cities in Jharkhand and thus leading to increased traffic activities. NH-32 (National Highway) is the most

important roadway in Dhanbad. It connects Gobindpur in Dhanbad district with Jamshedpur in East Singhbhum district in Jharkhand. Most of the occupational area and commercial hotspots of Dhanbad city have been developed on both sides of this highway. Intersections of NH-32 with local road network are the most preferred places for this type of establishments. The people, using these places on daily basis, are subject to continuous exposure of pollutants generated from the traffic activities at intersections. As Dhanbad is already burdened with huge pollutant load from nearby mines [2], vehicular emission from roadways worsen the air quality of those sites. Especially it contributes more in the particulate and nitrogen oxides concentration. Along with tail-pipe emission, fugitive emission from traffic due to break-tire wear, re-entrainment of road dust etc. also contribute largely in increment of particulate concentration and degradation of air quality.

Amongst all air pollutants, particulates are considered to be the most dangerous pollutant for health. Particulate matters (PM) are the pollutants of major concern for human health. They are the particles that are less than 10 μm in diameter (PM_{10}) and capable of entering the lungs easily [3]. PM can be further divided into three classes: coarse (10 to 2.5 μm; $PM_{10 - 2.5}$), fine (<2.5 μm; $PM_{2.5}$) and ultrafine (<0.1 μm; $PM_{0.1}$) particles. $PM_{2.5}$ is believed to be more detrimental to human health than PM_{10} [4]. Because of their small size, $PM_{2.5}$ and particles reach deeper into the lungs, and a large portion of those particles penetrate the alveoli and enter the circulatory system, posing threats to other viscera. The adverse effects of PM on the cardiovascular system have been proven in number of studies.

To know the impact of particulate matters on public health in Dhanbad city and to design any control or mitigation policy it is required to figure out the real-time status of air quality and proportion of PM_{10} and $PM_{2.5}$ at important commercial and occupational sites located at the intersections and compare with that of freeway road section. In this way, justification of the construction plans at those places for upcoming facilities can be done.

2. METHODOLOGY

Study area:

In this study two intersections and two freeway road segments on NH-32 were selected as monitoring sites to measure particulate concentration (Fig.1). Govindpur (GP) is the junction of NH-32 and NH-2. It is a three leg intersection. Other intersection is Randheer Verma chawk (RVC), which is a four way mini roundabout. Freeway sites were chosen at Big Bazar shopping mall (BB) and Indian School of Mines main gate (ISM) Another site, inside ISM campus which is away from the roadways, was taken as control site for background concentration measurement.

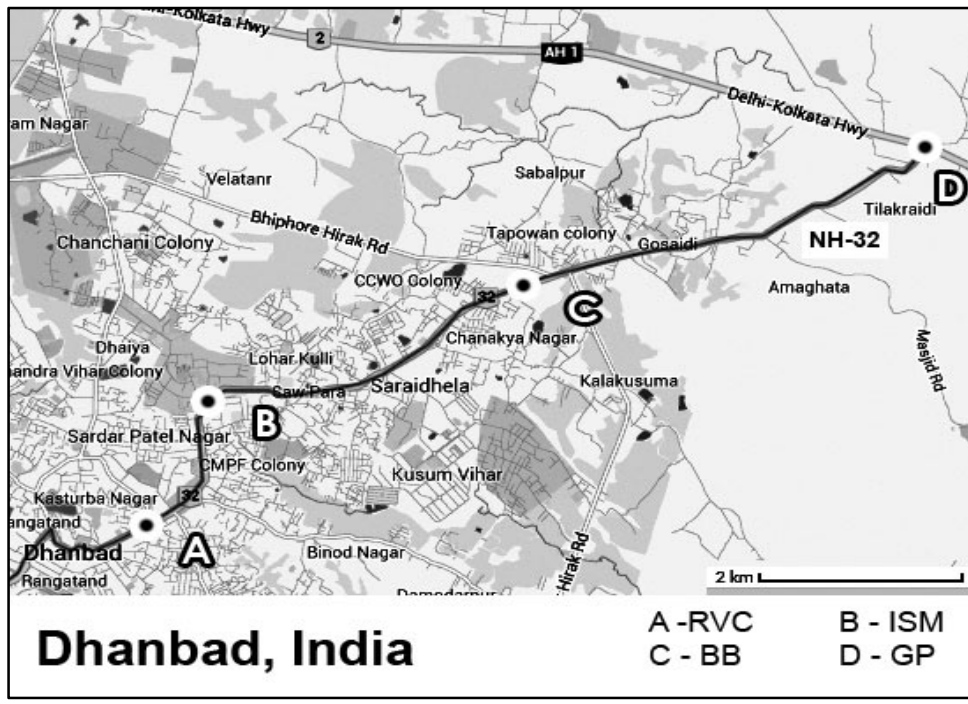

Fig.1: Location of Sampling Points

3. PARTICULATE SIZE DISTRIBUTION:

To measure the particulate count and concentration for various size classes, Portable aerosol spectrometer (Make: GRIMM) was used.

The instrument counts the particle number using Scattering laser light technology and measures the mass using filter collection method. Sample flow rate was 1.2 lit/min. 31 different classes of particulate size starting from 0.265µm to 34µm was considered for this study. The samples were collected at 5m downwind of the source.

The measurement was done for 10 different days in February 2014. The average count and mass values were used for each size class and locations.

4. RESULTS AND DISCUSSION

Particles with greater size were found to be in higher number at the freeway segments than that of the intersections, whereas the smaller particle count was found to be more at intersections compared to freeways (Fig.2). From the aspect of concentration, PM_{10} was found to be in greater concentration at the freeways: highest concentration was at BB followed by ISM. Lowest

concentration of PM_{10} was found at GP. In case of $PM_{2.5}$ concentration, GP showed the highest value and lowest value was found at ISM (Fig.3). Possible reason for increased PM_{10} concentration at freeway sites is the speed of vehicle at freeway segment is higher than that of intersections, resulting the higher rate of dust re-entrainment [5]. But smaller particles are mostly generated from tail-pipe emission [6, 7, 8], so the intersections, where the traffic activities are higher, shows greater concentration of finer particles. It can be seen in Fig.2 that, at control site, which is far away from road side, showed a significantly less count of finer particles. The result supports that the contribution of traffic activities in generation of finer particles are more compared to other factors.

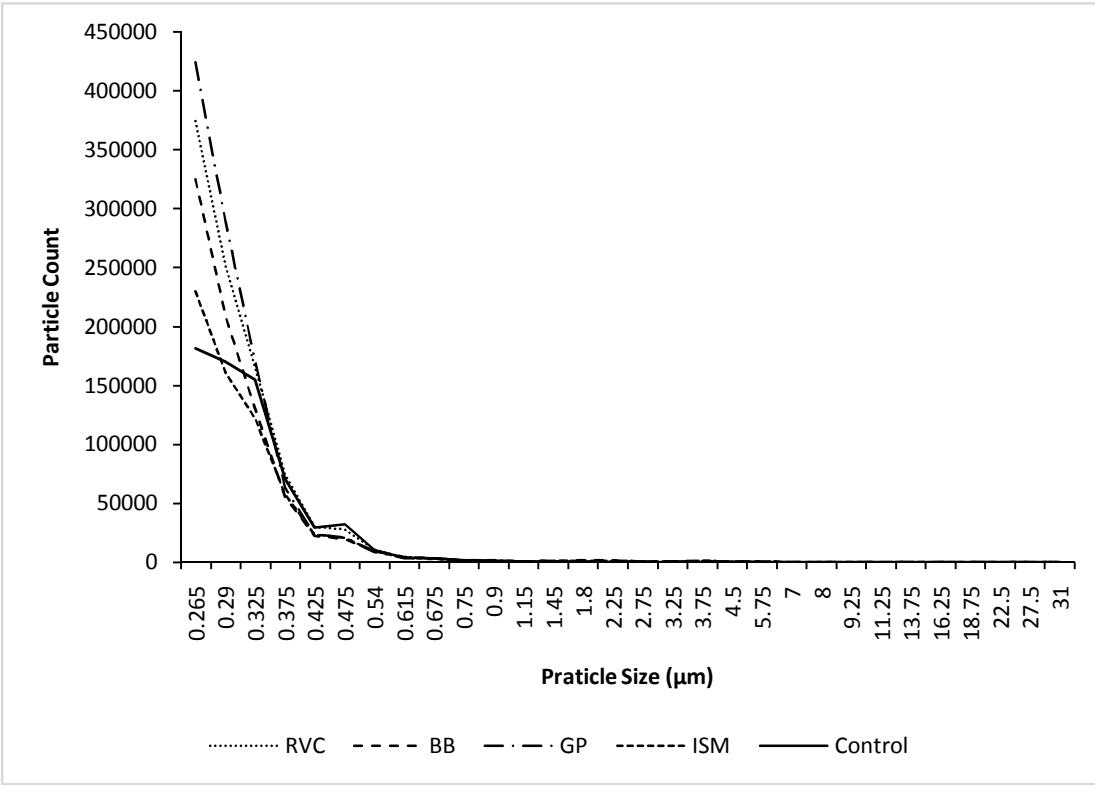

Fig.2: Distribution of particle count according to their size class at different locations

In case of PM_{10}, all sites excluding the control exceed CPCB (Central Pollution Control Board, India) and EPA (Environmental Protection Agency) NAAQ (National Ambient Air Quality) standard. For $PM_{2.5}$, all sampling points including control site showed concentration values beyond both NAAQ standards (Fig.3).

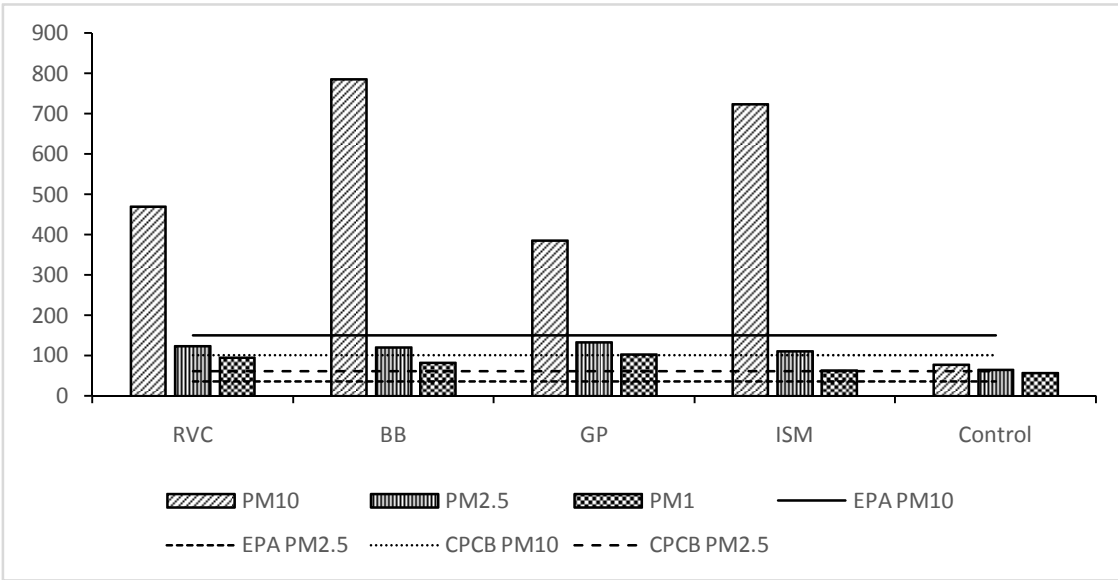

Fig.3: Concentration of PM_{10} and $PM_{2.5}$ at different sites and their compliance status with CPCB and EPA standards

5. CONCLUSION

This study brings the present horrible scenario of ambient air quality of Dhanbad into picture. As in terms of $PM_{2.5}$, none of the points selected may be considered safe for human beings. Although in case of PM_{10}, it was shown that the places far from busy roads still comply with CPCB and EPA standards, but the value is not very less from their acceptable limits. The control point showed relatively less count of ultrafine particulates, but when the aggregated mass of $PM_{2.5}$ is considered, it exceeded to outreach both standards. To maintain the public health of this city, the combined effort of researchers, regulatory bodies, policy makers and common people is required.

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