IIOAB JOURNAL
ISSN: 0976-3104

ARTICLE

QUALITY OF AIR AND NOISE LEVEL ASSESSMENT AT CONSTRUCTION SITE

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ABSTRACT

In a world that is fast moving towards intensive infrastructural development to meet the ever changing standards of globalization, the focus from environmental hazards has unfortunately been removed. Construction activities have seen an exponential rise over the years especially in Indian metropolitan cities which has brought along with it increased risks of ambient air pollution and noise pollution that have adverse effects on human life. With respect to the above problem statement, the focus has been to conduct a cohesive and comprehensive study on the effects of construction works with regards to air and noise pollution. The methodology adopted was to carry out the studies on the release of suspended particulate matter as a consequence of dust emission at the construction site using a High Volume Air Sampler. Other data like temperature of the day at site was recorded, wind speed at the site was recorded (from meteorological data) to relate variation of concentration SPM with climatic condition during the study period. The sound levels were also investigated using Sound Meter at the construction site simultaneously during the study period. An attempt has been made to find variation of the noise levels with working hours. The recorded SPM concentration at site was compared with National Ambient Air Quality Standards to assess the pollution level. Similarly the recorded sound levels were compared with National Ambient Air Quality Standards with respect to Noise. An attempt has been made to suggest mitigation measures that can be applied by institutions to counteract the harmful effects of dust emissions and noise pollution due to infrastructure projects that our development needs but also to safeguard our environmental needs.

KEY WORDS
High Volume Air Sampler, National Ambient Air Quality Standards, Sound Meter, Suspended Particulate Matter (SPM).

Published: 29 Sept 2016

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INTRODUCTION

Emissions of dust to air can occur during the preparation of the land (e.g. demolition, land clearing, and earth moving), and during construction. Emissions can vary substantially from day to day, depending on the level of activity, the specific operations being undertaken, and the weather conditions. In terms of effects, construction sites can give rise to annoyance due to the soiling of surfaces by dust. Very high levels of soiling can also damage plants and affect the diversity of ecosystems. Additionally, there is evidence of major construction sites increasing long term particulate matter (PM_{10}) concentrations and the number of days when PM_{10} concentrations exceed 100µg/m3 [1], the daily limit value for this pollutant. Exposure to PM_{10} has long been associated with a range of health effects. Controlling construction noise can pose special problems for contractors. Construction activities often take place outside where they can be affected by weather, wind tunnels, topography, atmosphere and landscaping. Construction noise makers vary considerably in its intensity throughout a work day. High noise levels on construction worksites can be lowered by using commonly accepted engineering and administrative controls. Normally, earplugs and other types of personal protective equipment (PPE) are used to control a worker's exposure to noisy equipment and work areas. According to the center for construction research and training (CPWR) 73% of all construction workers are exposed over the noise recommended exposure limit [2].

METHODS

Dust analysis

A. Initial Stage Heat the Whitman Glass Fiber filter paper for 15 minutes at the temperature 2°C - 3°C higher than the room temperature and cool it for 15 minutes then take its initial weight [3]. Then place the filter paper in High Volume Air Sampler and keep the sampler in construction site [Fig. 1]. As per to IS : 5182 (Part 14), 2000, the sampler should be placed at the height of 3±0.5 m from the ground level and should never be placed at the corner [Fig. 2] [3]. Now set the time between 4-6 hours and set it's flow between 900 lpm to 1200 lpm (liters per minute). Now switch on the machine and keep it running up to its set time.
B. Final Stage Once the machine is stopped then take the final weight of filter paper in weighing machine and do the calculation for SPM concentration.
C. Figures:

Noise analysis

A. Initial Stage Select some points around the construction site and then use the sound meter on each point to note down the noise level in dB (decibel) [Fig. 3]. Place the sound meter at 1.5m height from the ground level and 3m away from the source.
B. Final Stage At every 1 hour interval note down the sound level from each allocated points. Make the observation table to note down each data's.
C. Figure:

IIOAB JOURNAL
ISSN: 0976-3104

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Fig. 1: Inside view of high volume air sampler

Fig. 2: Placing of high volume air sampler on construction site

Fig. 3: Reading displayed in sound meter

Calculation for dust

Below is just a sample calculation to be done for obtaining the value of SPM of that particular day.
Initial weight of filter paper (W1) = 2.7345 grams
Final Weight of filter paper (W2) = 3.3490 grams
Weight of dust collected (W2-W1) = 0.6145 grams
Initial Flow = 900 liters/min=900/1000 = 0.9 m3/min
Final flow = 900 liters/minute=900/1000 = 0.9 m3/min
Time = 5 hours=5*60 = 300 minutes
Solution
Volume of air sampled at 32 degrees Celsius, 690 Hg = 300*.9 = 270 m3
Volume of air sampled at 25 degrees Celsius, 760 Hg = 300*.9 = 239.505 m3
P1V1/T1=P2V2/T2
» 690*270/(273+32)=760*V2/(273+25)
» V2 = 239.505 m3
Therefore, Suspended Particulate Matter (SPM) = (W2-W1)*106/V2
» 6145*106/239.505 = 2565.70 µg/N-m3.

Units for dust

- The SI unit for weight of filter paper and dust collected is in gms (grams).
- The SI unit for temperature is in K (Kelvin).
- The unit for volume of air sampled is in m3 (cubic meter).
- The SI unit for concentration of SPM is µg/N-m3 (micro gram per normal cubic meter).

Units for noise

- The SI unit for noise is in dB (decibels).

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ISSN: 0976-3104

Equation used for dust analysis

1. $$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

2. $$\text{Concentration of SPM} = \frac{\text{weight of dust collected}*10^6}{V_2}$$

Equation (1) is used for finding the value of V_2. Once V_2 is known than the concentration of SPM can be known with the help of equation (2).

RESULTS

Dust analysis

Below is the observation table with the highest value of SPM that is found on different locations [Table 1]. The work was conducted for 20 days on each sites and the readings were obtained with respect to it. The meteorological factors i.e. wind speed (in km/hr) and temperature (in °C) was also noted down and graph was plotted to see the relation between meteorological factors and SPM.

Time: 10:00 AM to 03:00 PM
Limit: 100 µg/Nm^3 [1]

Table 1: Highest value of SPM readings from different places of Bangalore

Places in Bangalore	Highest SPM readings	Places in Bangalore
Mathikere	2565.702 µg/Nm^3	Mathikere
White Field	2737.723 µg/Nm^3	White Field
Electronic City	2015.124 µg/Nm^3	Electronic City
Bannerghatta	1975.482 µg/Nm^3	Bannerghatta

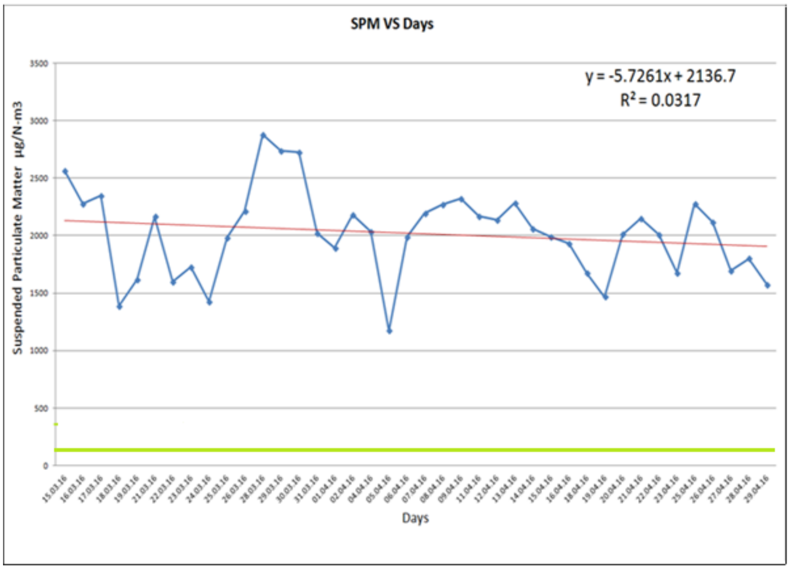

Fig. 4: Graphical representation of SPM vs. days

The graphical representation of SPM Vs Days by considering all the places together [Fig. 4]. The green line indicates the limit as specified by Indian regulations (100 µg/N-m3).

The graphical representation of SPM vs. temperature by considering all places together [Fig. 5]. As can be seen, the trend shows that SPM increases with increases in temperature. An instance where this trend is not followed is owing to the nature of work at construction. On correlation to preceding graph, one will note that overall SPM emission on these days was low due to reduced activity at site.

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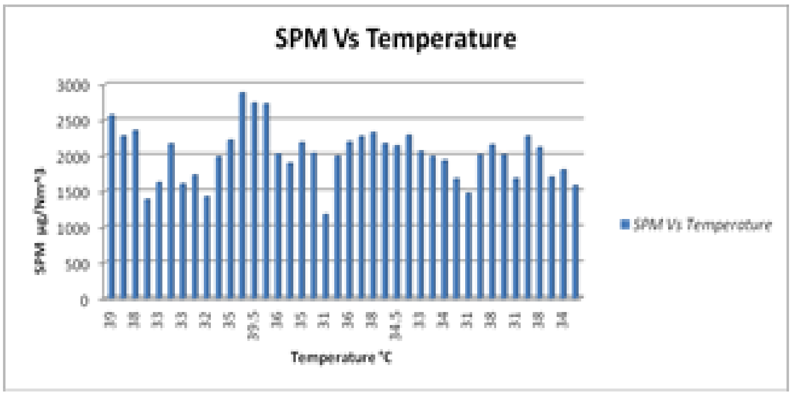

Fig. 5: Graphical representation of SPM vs. temperature

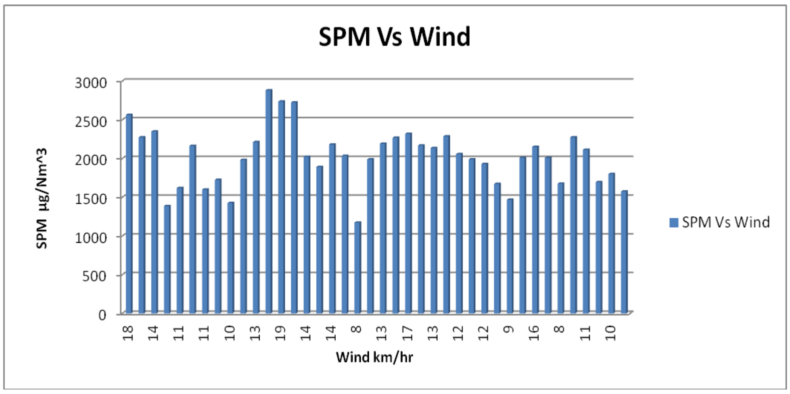

Fig. 6: Graphical representation of SPM vs. wind speed

The graphical representation of SPM Vs Wind speed by considering all places together [Fig. 6]. As can be seen, the trend shows that SPM increases with increases in wind speed. Instances where this trend is not followed is owing to the nature of work at construction. On correlation to preceding graph, one will note that overall SPM emission on these days was low due to reduced activity at site.

Noise analysis

Below is the observation table with the highest value of noise level found on different locations at different points [Table 2]. The readings were taken for 20 days and at each points reading is taken at an interval of 1 hour. Then the graph was plotted by combining all the points to check its effect with respect to time.

Time: 10:00 AM to 03:00 PM
Limit: For Commercial
Area: Day time - 65 dB [4]
Night time- 55 dB [4]

Table 2: Highest value of sound meter readings from different places of Bangalore

	Points	
Places	A	B
Mathikere	70.3 dB	68.5 dB
White Field	74.5 dB	70.4 dB
Electronic City	72.4 dB	68.7 dB

IIOAB JOURNAL ISSN: 0976-3104

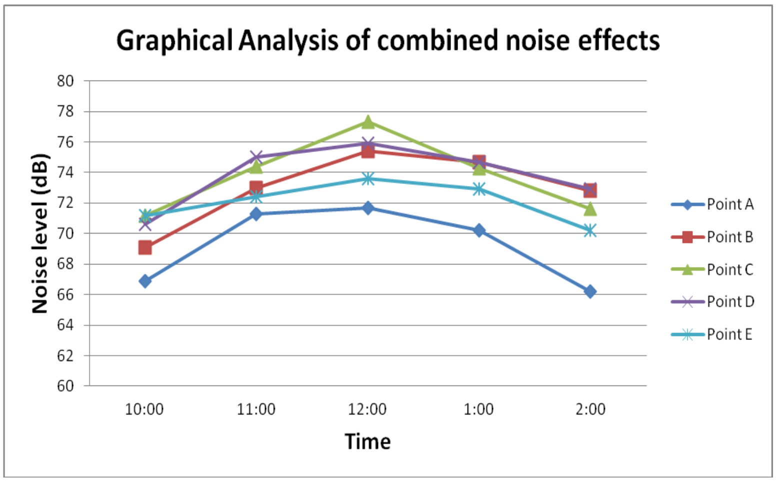

Fig. 7: Graphical representation of Noise level (dB) vs. time

The graphical representation of noise level with respect to time [Fig. 7]. As can be seen, the trend shows that the noise level increases most to the peak time of 12 noon afterwards the noise level gets decreased as the rate of work at construction site gets decreased.

SUGGESTIONS

Administrative measures

1. Develop and implement a stakeholder communications plan that includes community engagement before work commences on site [5].
2. Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the Local Authority. The desirable measures should be included as appropriate for the site [5].

Site management

3. Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken [6].
4. Hold regular liaison meetings with other high risk construction sites within 500m of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimized. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes [6].

Monitoring

5. Undertake daily on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary, with cleaning to be provided if necessary [7].
6. Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.

Preparing and maintaining the site

7. Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible [8].
8. Fully enclose site or specific operations where there is a high potential for dust production and the site is actives for an extensive period [8].
9. Keep site fencing, barriers and scaffolding clean using wet methods [8].
10. Spray water on the site after every half hour or 1 hour , so that all the dust particles will settle down and there will be less air pollution.
11. Grow more trees around the construction site.

For Noise

Basic controls

1. Construction noise makers, e.g., heavy earth moving equipment, can move from location to location and is likely to vary considerably in its intensity throughout a work day [9].
2. Normally, earplugs and other types of personal protective equipment (PPE) are used to control a worker's exposure to noisy equipment and work areas [9].

Engineering controls

Engineering controls modify the equipment or the work area to make it quieter. Examples of engineering controls are: substituting existing equipment with quieter equipment; retro-fitting existing equipment with damping materials and maintenance. Keep machinery covers and panels closed and well fitted. Bolts/fasteners done up tightly avoid rattles [9].

Administrative controls

These are management decisions on work activities, work rotation and work load to reduce workers' exposure to high noise levels. Typical management decisions that reduce worker exposures to noise are: moving workers away from the noise source; restricting access to areas; rotating workers performing noisy tasks; and shutting down noisy equipment when not needed [10].

CONCLUSION

From the above work it is already found that the construction site leads to emit very heavy concentration of suspended particulate matter (SPM) in the atmosphere and produces high amount of noise level which leads to noise pollution. As the limit provided by Central Pollution Control Board (CPCB) for dust [1] and noise [4] is found to be not at all followed at construction works which slowly affects our atmosphere. The values mentioned here are just for the four locations in the Bangalore, thus we can fairly make an idea that on whole the Bangalore city pollution is on higher scale. Thus we can conclude that the pollution coming from all the cities in India sums up and create a larger pollution and affects our environment adversely. It's a very high time that the mitigation measures are needs to be followed at each and every state's construction sites.

CONFLICT OF INTEREST

There is no conflict of interest.

ACKNOWLEDGEMENTS

The first author acknowledges the immense help received from the Tanoy Dutta, Bryan Andrew Kharshandi and Nripendu Sharma (students of MSRIT, Bangalore). The author is also grateful to publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

FINANCIAL DISCLOSURE

None.

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