Construction Dust Management to Reduce the Impact on Environment

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Abstract*— The construction sector is a massive industry that contributes significantly to the national economy and can be considered the base of all other sectors. However, the detrimental effects of construction site activity and pollution are a major problem for nations, including India. Construction pollution raises the death rate and the number of patients with various serious illnesses in these countries. It reduces the life span of human beings various forms of pollution, including those from landfills, the air, water, and noise, arise during construction. Everyday exposure to air, water, and noise pollution has an influence on humans as well as the environment and ecosystem. PM10, PM2.5, SOx, NOx, and volatile organic compounds are among the air pollutants whose intensity has reached a high level. Dust pollution may be caused by a variety of sources, including the usage of various construction equipment on the job site, transportation, and various construction operations. Correctly identifying these variables can aid in the implementation of control measures that can lessen the amount of dust pollution at the location. The author of this paper examines the various researchers' works that illustrate the influence of construction pollution. There is inadequate monitoring and verification of site activities in nations where the effect level is high. Countries minimize the majority of patients with these types of diseases if all precautions are taken on site and appropriate maintenance is carried out there.

Index Terms*— Construction industry, construction equipment, control measures, monitoring, Construction dust

I. INTRODUCTION

Air Pollution is the release of pollutants such as gases, particles, biological molecules, etc. into the air that is harmful to human health and the environment.

Any physical, chemical, or biological alteration to the air is referred to as air pollution. The air pollution caused by dangerous gases, dust, and smoke has a significant impact on humans, animals, and plants.

The atmosphere contains a specific percentage of gases. It is detrimental to survival if the composition of these gases changes. Global warming is the term used to describe the rise in earth's temperature caused by this imbalance in the gaseous composition. Air pollution has become a serious environmental issue that affects ecosystems, economic activity, and human health. Considerably all the air pollutants, particulate matter (PM10) and PM2.5—particulate matter with a diameter of less than 10 and 2.5 microns—present the public with the biggest health risks. A variety of particle sizes (PM10 and PM2.5) and material kinds (such silica) are found in dusts from various civil engineering and construction activities, and these dusts are known to be one of the main causes of air pollution in India. Numerous on-site activities, such as digging, excavation, and drilling, large amounts material transport, loading and unloading of dusty substances, open-air material storages, concrete production, stone crushing, cutting, and filling, equipment and vehicle movement, and so forth, produce construction dust.

In light of India's harsh summer and winter seasons, dust pollution has increased recently. The situation has become worse every year, forcing the National Green Tribunal (NGT) and other regulatory bodies, such as the Commission for Air Quality Management in the National Capital Region and Adjoining Areas (CAQM), to issue directives, guidelines, GRAP orders, and other actions to construction projects, requiring them to strictly abide by all laws and regulations pertaining to dust pollution. When construction activities violate established norms, there are legal repercussions, which may include being banned from operating on the site.

This approach is expected to help reduce air pollution by assisting with dust control. However, daily

conditions are terrible, especially in the summer and winter when Delhi's AQI level of air pollution falls between the very poor and severe +category.

Construction sites must use shade netting, cover debris, barricade, and sprinkle water every day to control dust. To improve the air quality in and around the sites, a thorough framework approach is necessary.

II. RESEARCH PROBLEM

A. Review Stage

A significant portion of pollution in the environment occurs due to a drastic boom in construction, renovation, and demolition activity, which leads to the generation of various pollutants that include PM2.5, PM10, SOx, NOx, and others. In the upcoming decades, as these cities' economies, populations, and physical areas grow, the demands of construction will expand the intensity of the pollutants in the environment. There were laws and enforcement agencies formed to monitor the effective implementation of laws and follow environmental dust mitigation methods to reduce the adverse impact on human health and the environment.

III. OBJECTIVE

The objective is to assess and determine the following aspects of the construction dust management process:-

- To understand the major sources of the pollutant generation inside the site premises.
- To understand the method and guidelines released by the UPPCB and NGT to follow during construction activity.
- To understand the engineering controls and latest technology available to deal with construction dust management.
- To analyses, the pollutant data recorded through the ambient air monitoring devices through NABL authorized labs / MERV-X device.
- Generation of comparative charts of pollutant recording and limit permitted.

IV. METHODOLOGY

The following steps must be taken in order to evaluate the present issues with dust and air pollution at construction sites and to identify any mitigation, control, and management strategies that are required in light of the site's current conditions: The following actions need to be conducted in order to assess the current dust and air pollution problems at the linear construction projects and to determine any necessary mitigation, control, and management methods depending on the current site conditions:

a. In Noida Sec-150, two to three notable spots were identified based on variances in the surrounding area (such as residential and quiet zones).
b. a site visit to identify the area of a particular location where dust pollution is an issue;.
c. Measuring the average concentrations of PM10, PM2.5, SO2, and NOx particulate matter both upwind and downwind;
d. Compiling relevant data from secondary sources.
e. Determine the source of the dust pollution problem;
f. Analyze the trend in the ambient air quality monitoring data at the site and compare it to the "NAAQS";
g. Develop suggestive mitigation solutions in compliance with various standards / criteria

V. AREA STUDY

Noida Sector-150, the fastest developing areas in the Uttar Pradesh where many MNCs are involved to develop the residential flats by which many air pollutants are generating during the course of construction activity, which have significant impact on environment and human health. The authors covers the construction dust management during the construction to reduce the impact on environment and human health.

The study covers the assessment of air pollutant recorded in the ambient air and control measure implementation to reduce the air pollutant in environment and adverse effect on human beings.

Photo 1-,Aview Merv-X Intelligent quality monitoring

Photo 2, Ambient air pollutant sampler

VI. POLLUTION FROM CONSTRUCTION

It is imperative for the construction industry to address the issue of pollution. The three primary forms of pollution that you should be mindful of are noise, water, and air. Hazardous waste management requires preventive measures that might have a direct impact on local residents and site workers. This involves harming their health permanently, since there is a worrying connection between pollution and cancer. Emissions into the atmosphere caused by humans are referred to as air pollution. The World Health Organization estimates that the combined impacts of household and ambient air pollution cause 6.7 million premature deaths annually, making poor air quality a global health risk. Furthermore, a major factor in global warming and subsequent climate change is air pollution.

Organizations in the construction industry have a shared obligation to reduce the amount of air pollution they emit, as building activities are a major contributor. As a result, conscious of the emissions that generates and take preventative measures to lessen any negative effects. The following are typical construction operations that cause air pollution:

1. Vehicle and plant usage on the property. This can include equipment like breakers, bulldozers, dumpers, and excavators, depending on the site's activity. Government regulation of plant and machinery is not as strict as it is for other types of vehicles when it comes to construction sites. Because many building projects are large-scale, machinery frequently runs for extended periods of time, emitting pollutants. Due to the diesel engines used in many of the heavy machinery and other vehicles on the property, pollutants are released into the atmosphere. The gases carbon monoxide, carbon dioxide, hydrocarbons, and nitrogen oxides are included in this.
2. Land clearing and demolition- Since it is frequently necessary to clear land and prepare it for development, care must be taken to ensure that the procedure has the least negative environmental effects possible. High amounts of dust are produced during building construction as well as when existing buildings are removed and the land is disturbed.
3. Chemicals.it may include paints, glues, oils, thinners and plastics, which all produce noxious vapors.
4. PM10 these large quantities of construction dust from cement, concrete, silica and wood are collectively classified as PM10. PM10 is particle matter less than or equal to 10 micrometers in diameter that is invisible to the naked eye. The diesel engine exhausts of plant and other vehicles is also a large contributor to PM10 emitted at construction sites. Specifically, this is referred to as diesel particle matter (DPM) and contains sulphates and silicates that add to the pollutants in the atmosphere.

VII. IMPACTS OF IMPROPER DUST MANAGEMENT

1. Employees

Studies on PM10 have revealed that breathing in contaminated air can cause the gas to enter the lungs deeply. Regular construction site workers run a higher chance of experiencing health issues as a result of their profession. The following health issues may result from poor air quality brought on by pollution:

- breathing difficulties, wheezing, and coughing.
- illnesses of the heart and lungs.

- lung cancer.
- Strokes.
- asthma attack worsening.

It's true that the construction industry accounts for 56% of male occupational cancer cases. Among these is mesothelioma, a cancer of the lining of the chest and lungs for which asbestos exposure is the only known cause. The high incidence of lung cancer among construction workers can be attributed to their frequent exposure to dusts and fibers, including asbestos and silica, as well as the gases and fumes released by moving trucks and machinery. As a result of routine work tasks, employees in the construction business may be exposed to fifteen to twenty carcinogens.

2. Local Residents

The consequences of air pollution may also be felt by adjacent residents who live near building sites. Locals may suffer the consequences of poor air quality even after the project is finished, even though they won't be as close to the pollutants as workers are. Wind carries PM10 and other air contaminants to the surrounding region, where they may settle. Here, people frequently inadvertently breathe them in, which might have the temporary effect of making them cough or become dyspneic.

3. Environmental

- Air pollution affects the environment in addition to the effects on human health. One-fifth of PM2.5 (particle matter with a diameter of 2.5 micrometers) and 8% of PM10 emissions originate from construction sites. This is mostly from diesel-powered generators and construction equipment; the remaining 1% is dust from demolition and other site operations. Because of this contamination, both plants and animals find it difficult to survive, which reduces biodiversity and upsets the balance of the food chain.

Preventive measure required to mitigate the impact

- Never burn waste materials. Doing so will cause smoke, releasing poisonous gases such as carbon monoxide into the atmosphere.
- Adopt hybrid technology in place of diggers and excavators with diesel engines. For example, Volvo is currently trialling a prototype hybrid excavator that runs on electric power generated from the down-swing of its boom arm.
- Use low sulphur diesel to power equipment and vehicles.
- Improve your existing equipment by using particulate filters and catalyst converters.
- Use water sprays or sprinklers to control some types of dust and stop it spreading. This will be particularly beneficial during tasks such as the filling of skips or breaking down of concrete.
- Use an on-tool extraction to control some types of dust. This is a type of exhaust that fits onto some tools and removes dust as it is being produced.
- Source local materials to avoid the need for them to be transported hundreds of miles.
- Use renewable or sustainable materials, such as timber from sustainably managed forests.
- Wear appropriate PPE, such as the correct type of respiratory protective equipment (RPE) depending on the task.

NATIONAL AMBIENT AIR QUALITY STANDARDS

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), µg/m³	Annual*	50	20	- Improved West and Gaeke -Ultraviolet fluorescence
		24 hours**	80	80	
2	Nitrogen Dioxide (NO_2), µg/m³	Annual*	40	30	- Modified Jacob & Hochheiser (Na-Arsenite) - Chemiluminescence
		24 hours**	80	80	
3	Particulate Matter (size less than 10µm) or PM_{10} µg/m³	Annual*	60	60	- Gravimetric - TOEM - Beta attenuation
		24 hours**	100	100	
4	Particulate Matter (size less than 2.5µm) or $PM_{2.5}$ µg/m³	Annual*	40	40	- Gravimetric - TOEM - Beta attenuation
		24 hours**	60	60	
5	Ozone (O_3) µg/m³	8 hours**	100	100	- UV photometric - Chemiluminescence - Chemical Method
		1 hour**	180	180	
6	Lead (Pb) µg/m³	Annual*	0.50	0.50	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours**	1.0	1.0	
7	Carbon Monoxide (CO) mg/m³	8 hours**	02	02	- Non Dispersive Infra Red (NDIR) spectroscopy
		1 hour**	04	04	
8	Ammonia (NH_3) µg/m³	Annual*	100	100	-Chemiluminescence -Indophenol blue method
		24 hours**	400	400	
(1)	(2)	(3)	(4)	(5)	(6)
9	Benzene (C_6H_6) µg/m³	Annual*	05	05	- Gas chromatography based continuous analyzer - Adsorption and Desorption followed by GC analysis
10	Benzo(a)Pyrene (BaP) - particulate phase only, ng/m³	Annual*	01	01	- Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), ng/m³	Annual*	06	06	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni), ng/m³	Annual*	20	20	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note. — Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

Table 1- National Ambient Air Quality Standard

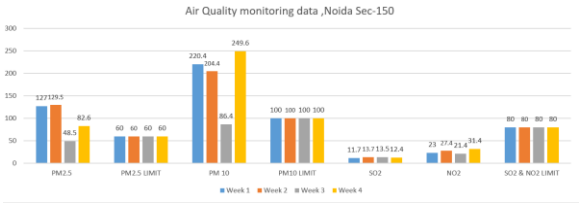
VII. ANALYSIS OF AMBIENT AIR QUALITY DATA

The labor colony, concrete batching plant, material storage, cement godown, transportation of construction machinery, equipment, and site vehicles, soil excavation, etc., are all set up at the construction site. These actions are thought to be possible causes of dust pollution. Additionally, the quiet weather that prevails throughout the winter months helps to stabilize the atmosphere, which slows the spread of pollutants and contributes to the accumulation of pollutants close to the sources of pollution. The winter season's lower average mixing height led to less troposphere accessible for mixing, which raised ground level concentrations of PM2.5 (48.2 µg/m3) and PM10 (86.8 µg/m3). As a result, the site's air quality has deteriorated to an alarming level.

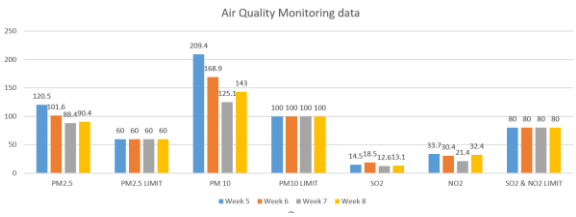
Air Quality monitoring data ,Noida Sec-150
Jan 2024-March2024

Pollutants	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
PM2.5	127	129.5	48.5	82.6	120.5	101.6	88.4	90.4	103.4	49.5	58.6	198.4
PM2.5 LIMIT	60	60	60	60	60	60	60	60	60	60	60	60
PM 10	220.4	204.4	86.4	249.6	209.4	168.9	125.1	143	17.4	178.6	132.4	302
PM10 LIMIT	100	100	100	100	100	100	100	100	100	100	100	100
SO2	11.7	13.7	13.5	12.4	14.5	18.5	12.6	13.1	14.7	12.5	10.5	20.4
NO2	23	27.4	21.4	31.4	33.7	30.4	21.4	32.4	34.4	12.4	19.4	38.6
SO2 & NO2 LIMIT	80	80	80	80	80	80	80	80	80	80	80	80

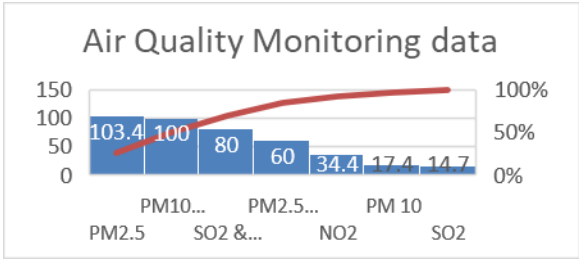
Table 2- Air Quality monitoring data



Graph 1- Air quality data for 1st 4 week



Graph 2- Air quality data for the period-5th to 8th week



Graph 3- Air quality data for the period-9th to 12thweek

VIII. DUST CONTROL MEASURES

a) In order to minimize dust, the Contractor must water all unpaved roads on all building sites at least three times per day during dry weather. In dry and windy weather, the Contractor must also follow the same watering schedule for exposed soil areas.
b) When transported on or off-site by trucks, all loose material with fine grains (soil, sand, etc.) must be covered with safe tarpaulins.
c) The fastest allowed vehicle speed on all building sites shall be 20 kmph at all times.
d) Before traveling on public roadways, all vehicles must have access to and use wheel washing facilities at all locations.
e) Equipment that is likely to create a lot of dust, such as crushers, should be placed downwind of the direction of the prevalent wind and at least one kilometer away from the closest inhabited area. To install and run any crusher units, a permission/NOC from the State Pollution Control Board is required. The proper dust reduction and extraction equipment should be installed on all such gear.
f) Using water tankers that are always accessible for this reason to irrigate site roadways and other exposed soil areas to reduce dust during the dry season.
g) Topsoil removal prior to excavation; storage for later use, with precautions taken to avoid dust accumulation or erosion from stockpiles.
h) Access routes and internal site roadways must always be appropriately constructed and maintained.

Photo 3.- Covering of sand

Photo4, The places not serviced by water tankers can be sprayed with water by hand.

Photo 5, water sprinkling by the tanker

Photo 6, dust mitigation by Anti-smog gun

Photo 7, Green net fixing on building face to prevent movement of dust

Photo 8, Water sprinkler installed in the batching plant raw material bins

Photo 9, Dust duct installed inside cement go down to collect the cement dust directly into bags.

IX. ABBREVIATIONS AND ACRONYMS

PM –particulate matter
RPE-Respiratory protective equipment.
NOC-Non Objection Certificate
GSB- Granular subbase
DPCC-Delhi Pollution Control Committee
CAQM-Commission for Air Quality Management in the National Capital Region and Adjoining Areas
GRAP- Graded Response Action Plan
AQI-Air quality index
NAAQS- National Ambient Air Quality Standards

X. COMPARISON WITH EXISTING RESEARCH

In keeping with the presumptions and system boundaries of other studies, this section compares the results with those of prior studies on Construction dust management to reduce the impact on environment. Although the life cycle inventory and impact assessment numbers in our study are greater than those published elsewhere, the overall results of the literature review, indicate that dust mitigation measure taken religiously on ground reduces the adverse effect on the environmental.

Table 1 air quality monitoring data indicates the existing condition has higher PM2.5, and PM10 pollutants concerning limits, but SOx and NOx values are less than the permitted limits. Therefore, the condition and pollutant intensity vary from location to location due to the dependency on the various activities that contribute to the poor quality of the environment. Therefore, dust control measures must be implemented seriously and consciously to make a greater positive difference and improve environmental conditions.

XI. LIMITATIONS AND FUTURE WORK

The device, which were setup, are sampling for the overall condition to reflect the environment impact scenario. The data generated may be varied due to intensity of work going on in the particular period and the device setup not meets the criteria set at national level.

The adequate monitoring require to collect the more efficient data and work scope in high in this subject due to climate and environment requires higher side focuses at all levels. The control measure which are subjected to in places require to be strict implementation and enforcement for tightly implementation to reduce overall impact on environment,

CONCLUSION

The dust produced at building sites has a detrimental effect on workers' health and well-being in addition to having an adverse effect on the environment. Based on the review, it is evident that several variables such as construction activities and on-site transportation are the primary causes of the dust emission. Effective dust management techniques can be implemented with the assistance of identifying these elements.

Along with these methods, raising awareness can help reduce the amount of dust pollution that comes from building sites.

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