Monitoring of Dust particles in and around the newly constructed of four-lane highway connecting Tezpur and Itanagar using Foldscope

[1]Munmi Gogoi, [2]Dr. Dilip Saikia*
[1]Junior Research Fellow, [2]Assistant Professor
[1,2] Department of Physics
[1,2] Pandit Deendayal Upadhyaya Adarsha Mahavidyalaya, Behali, Biswanath, Assam-784184, India

Abstract: Construction activities of road and building constitute an important source of environmental pollutant mainly particulate matter (PM) emissions. One of the common example of air pollution due to PM is heavy constructions of road that may cause a substantial temporary impact on local air quality. In this piece of work, we are going to study the air pollutant created at different phases of construction of four-lane highway using foldscope. Substrate is designed and installed at the construction site of four-lane highway to collect dust particles. An acrylic adhesive clear double-sided tape is used to design the substrate, substrates are mounted at a height of 6 feet from the ground at several locations and kept for 45 days and dust particles are allowed to deposit on the substrate. Samples collected from the different place are analyzed by using foldscope and size of the dust particles are estimated using simple techniques (using foldscope). For the estimation of the size of dust particles, PVC 0.85mm thickness slides of 1mm and 0.5mm grids are used. From the result observed it is seen that the dimension of dust particles deposited on the substrates are of the order of 10^{-2}mm. We have also estimated the size distribution of the dust particles that collide the substrate at a height of 6 feet above ground for the different sites.

I. INTRODUCTION

It has long been recognized that construction activities of road and building constitute an important source of environmental pollutant mainly particulate matter (PM) emissions. Dust particles are defined as PM which are suspended into the atmosphere by several means such as explosion, windblown suspension of geologic, mechanical processing of materials, including grinding, crushing, rapid impact, detonation, handling, and decrepitation of organic and inorganic materials such as rock, ore, and metal [1, 2]. One of the common example of air pollution due to PM is heavy constructions of road that may cause a substantial temporary impact on local air quality. During the process of construction, emissions of dust particles may occur by several construction activities such as movement of equipment over unpaved surfaces, excavation activities, cut and fill operations, land clearing, wind erosion of soil exposed by construction activities, crushing etc. Emission of dust from construction activities differs from other dust sources due to the temporary nature of the period of the construction process. The temporal nature of construction period indicates that there are definable beginning and ending of dust emissions from any single construction site, and it varies substantially over different phases of the construction process. The quantity of dust emissions during construction operations is influenced proportionally by the area of land being covered and to the level of construction activity. Emissions of dust particles from heavy construction operations can be positively correlated to the content of silt (particles smaller than 75 μm) in the soil of construction, as well as with the weight and speed of the average vehicle, and can be negatively correlated to the moisture content of the soil. Estimation of dust emission are important and help environmental policy makers to permit a new heavy construction work in a developing country like India. Suspended PM matters emitted from construction work have a substantial visible adverse effect on the local air quality during the ongoing construction activities [3]. It causes health problems, reduced air visibility, harmful effect on the ecosystem and thus has to be assessed and quantified so that it could be minimized. Studies have rarely been focused on quantification of dust generation from sources. Due to difficulties on detection of the dust cloud and many uncontrollable affecting factors during construction process studies are rarely focused on the quantification of generation of dust particles.

II. MATERAILS AND METHODS

a. Study area

The area under the study starts from newly constructed four-lane highway starting from Tezpur to Arunachal Pradesh and emphasis has been given to the tea garden area. Biswanath (26°43'35.99"N, 93°8'52.26"E) is a district of middle Assam on the northern bank of the river Brahmaputra and most part of which is covered with tea garden. Three sites have been selected for sampling site 1: Borgang (Kettela Tea Estate), site 2: Helam (Helam Tea Estate) and site 3: Purupbari (Gohpur Tea Estate) clearly shown in the Fig 1.

Figure 1: Map of the sampling site

b. Experimental Methods

Foldscope is also a powerful tool to analyze different types of microorganisms in our environment, a study of a different type of microstructures in nature, different types of biological samples etc. As we all are aware of that microscopes are universal tools in science and technology that provides a visual connection between the familiar macro-world and the remarkable underlying micro-world. Foldscope is an optical microscope based on origami which is designed by Stanford University, Stanford, California, United States of America. The working principles of Foldscope are based on optical design and origami, it can be assembled from a flat sheet of paper within 10 minutes. It is a cost-effective paper-based microscope, having a magnification up to 2000x with a submicron resolution depending on the type of lens used. The greatest advantage of this microscope is its durability, portable size and external powerless operation [4]. Using this unique platform, we have presented our ideas to explore the micro-world by using innovative techniques. This platform, i.e Foldscope, is integrated with a smartphone for capturing images of the samples and display of results. Camera used to capture the images has optical image stabilization facility and other technical specifications are mainly sensor: Sony IMX 519 with 16 megapixels, pixel size 1.22 µm and aperture: f/1.7. The substrate is designed and installed at the construction site of four-lane highway to collect dust particles. Acrylic adhesive clear double-sided tape and microscopic slides of dimension 75mm x 25mm are used to design the substrate, substrates are mounted at a height of 6 feet from the ground at several locations and kept for 45 days and dust particles are allowed to deposit on the substrate.

III. RESULTS AND DISCUSSION

Image of the dust particles deposited on the surface of the substrates are collected and viewed under foldscope some of the images of the samples collected from three different sited is shown in the fig 2.

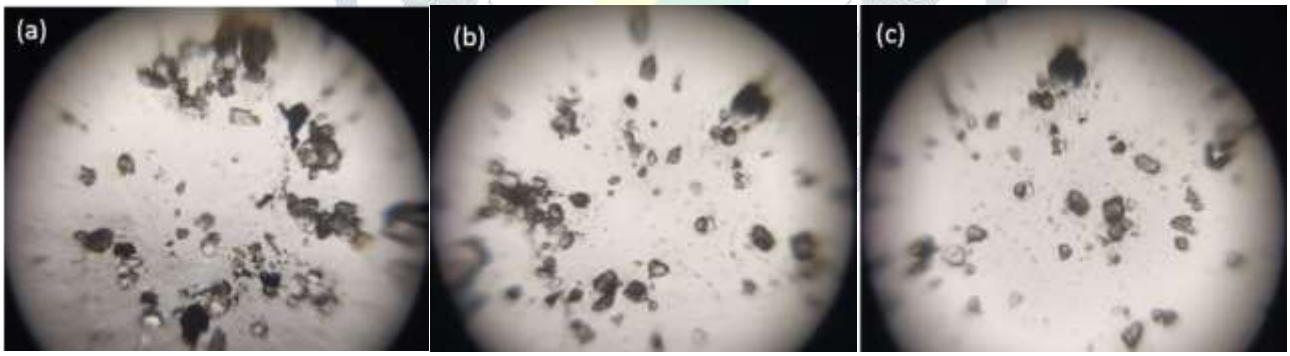
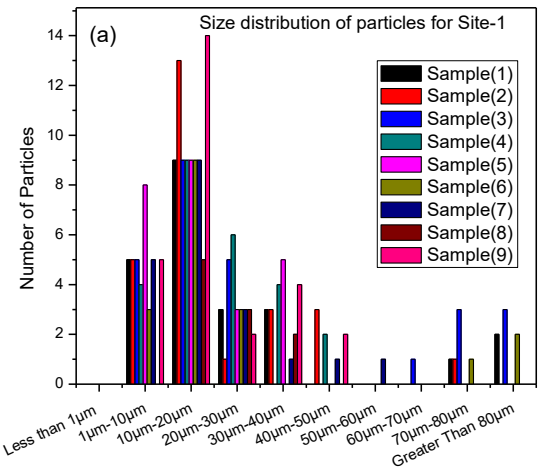


Figure 2: Image of the samples collected from three different sites (a) site 1, (b) site 2 and (c) site 3.



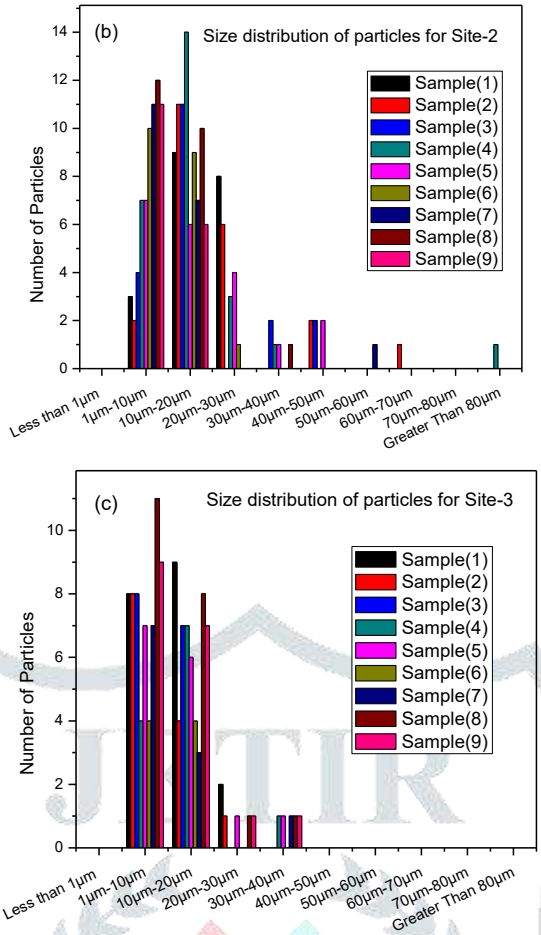


Figure 3: Size distribution of the particles for three different sites (a) site 1, (b) site 2 and (c) site 3

In our study we have collected different samples from the three sites and images have been taken for all the samples, for analysis of size distributions nine images for each of the three sites have been taken. Measurement of the size has been carried out by the help of relative measurement method in which we have used PVC 0.85mm thick slides of 0.5mm grid size as a reference for measurement. Size of the particles was calculated manually by comparing it with the standard grid. From the result, it has been noticed that the size of the particles varies from few 3 μm to 80 μm. Bar diagram for the size distribution of the particles is shown in fig 3. Fig 3(a), Fig 3(b) and Fig 3(c) clearly indicates that for the three sites a maximum number of particles falls in the size range of 1-20 μm. Dust particles diameter less than 10 μm referred PM10 which are inhalable particles were mostly found in the samples. Matters in finer dust particles could cause a greater risk to human health including respiratory diseases, cardiovascular diseases and even mortality [5] because they are easily re-suspended into air particles with aerodynamic diameter less than 100 μm termed as PM100 are adhered to skin easily [6] especially the PM10. On the other hand particles with aerodynamic diameter, less than 2.5 μm termed as PM2.5 may be deposited in the upper respiratory tract and the alveolar regions of the lung, respectively [6]. Hence, it is very important to know the size distribution pattern and sources of matters within the three fractions of particles.

IV. Conclusion

We have studied the effect of the construction of the four-lane highway connecting Tezpur, Assam to Itanagar, Arunachal Pradesh on the emission of dust particles giving emphasis to the areas nearby tea garden and selected three sites namely site 1: Borgang (Kettela Tea Estate), site 2: Helam (Helam Tea Estate) and site 3: Purupbari (Gohpur Tea Estate). Substrates were designed and mounted at a height of 6 feet from the ground at different locations of the three sites. Foldscope image of the samples was taken for analysis. From the particle size distribution, it is clear that most of the particles detected falls under PM10. Such kind of study for the analysis and monitoring of environmental pollutions caused by the highway construction using foldscope has been reported for the first time.

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