3 Airborne Particulate Distribution and Removal (Settling) by Statistics Interest and Physicalness

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Abstract

Although it's not new to describe airborne particulate settling by nature of statistics or probability frequency distribution (PFD), but this present study would enrich the subject of aerosol science and its behavioural analysis. This study has explored several insights on settling phenomenon of particulate matter in ambient air. These insights are completely new or newly explained to the study. However, to narrate such several insights, the study has applied the subjective interpretation, combined with logical motions and innovation. Three-dimensional visions on particulate settling and its behavioural characters has been applied and PM10 is kept at point of limelight in the study. Totally, this paper is going to be highly interesting alongwith various research scopes. Specifically, built-up environment and its concern to climate-change abatement would get new-age cutting-edges by innovation and creative designs, by the study. Readers would find this study useful with theirs' own enrichment of subjective knowledge-depths surely and out-the-most a satisfaction to become a seer to the new theory of various dimensions evolve.

Keywords

Aerosol, Impending tubule, Probability frequency distribution, Settling innovation, Settling by statistics, Settling trajectory.

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1. Introduction

"Settling of clouds of pollution is the demand and clouds to be made up by statistics, for a city (to) clean"- with this theme the study of airborne particulate setting is to be best expressed by. With upgrowing urbanization, most of cities all around world are re-thinking again and again (many a times!) to how to provide serviceability standard of better degree to its peoples [1], [2]. On this vision, upgrading versions in the definition of a city (and its standard) are used to come in views and news always. For name of a few it may include definition like smart city, ultra city, modelled city or hybrid city model [3], [4], [5]. On many of its directions, this is going to be an unending subject of future civil engineering where multi-variable aspects are to be thought of and provided with serviceability standards to its nation [6]. In recent updation, various ratings (like LEED certification - Leadership in Energy and Environmental Design that is a building certification) have come up in our new-age urbanization to be an indicator of energy-efficient building structure and this present study could be useful to that also [7], [8].

Understanding of behaviour of airborne particulate in their settling or dispersion or distribution character has been going on in the field of air pollution or aerosol science and engineering[9], [10]. Various studies have been done onto knowing how particulate (especially PM10) settling occurs in ambient atmosphere [11]. While this present study delivers the explanation of settling character enhanced by statistical analyses (especially, standard normal distribution, or, probability frequency distribution (PFD)), theoretically, the proclamation as an objective would be not at all away from the study itself. The study has expanded the proclamation onto highlighting further research extractions (on knowing particulate settling character by statistics' way) by its own way of analytical methodology with rational feasibility. The study has followed basic fundamentals of aerosol settling and interpreted the characters of settling through exploration of research insights, subjectively. Such insights are hereby said to be newer ones. Entire study is theoretical and of academic interests. Such a study as explained herein could explore out various insight-making pathways to understand and propagate with to discover many other exploitable knowledge/area that's not yet discovered. The study hopes that it would make a progress onto the thought or perspective of the subject as well, to go furtherance through the given platform of knowledge perceptions, as provided in it.

It is always a complex task to tackle pollution at source and find their source apportionment clearly. For airborne particulate pollution, re-suspension of road-dusts might often cause ambiguity or errors in their right (righteous!) estimation or finding [12], [13]. For sake of air pollution measurement or anticipation, stability or correct acquaintances of (prevalent) atmosphere along with various others at a location is the utmost thing to take care of[14], [15]. In fact, if these are possible then human activities (from road-side tea-stalls to new car/engine innovations) might resemble as secondary or non-influencing object to "particulate" air pollution. So, it all-in-all needs landscaping (i.e., land use "effectiveness" of built-up environment) alongwith correct anticipation of particulate pollution by its movement in the air.

Particulates are necessarily air-borne in ambient atmosphere [1]. This study explains settling of particulates by way (theoretical) of statistical distribution [16], [17], [18]. In addition, there are various statistical modelling taken into consideration of settling study or analysis like [19], [20] and many more. This present study is theoretical totally and explained by keeping up the background of conventional fundamental of statistical distribution on the settling.

Figure 1 shows an illustrative layout of formation, distribution, transportation and settling of particulates from a given source. Though it's an elevation view but it also depicts two zones of settling (PM10 and PM2.5) horizontally along a given road. PM10 is, comparatively, known as higher sizes than PM2.5. The study is about determining profile nature of PM10 ONLY and various approaches or innovations made up to

bring down limit of concentration (of PM10) well below permissible value. In the study, PM10 and PM2.5 settling is termed by 10 settling and 2.5 settling respectively.

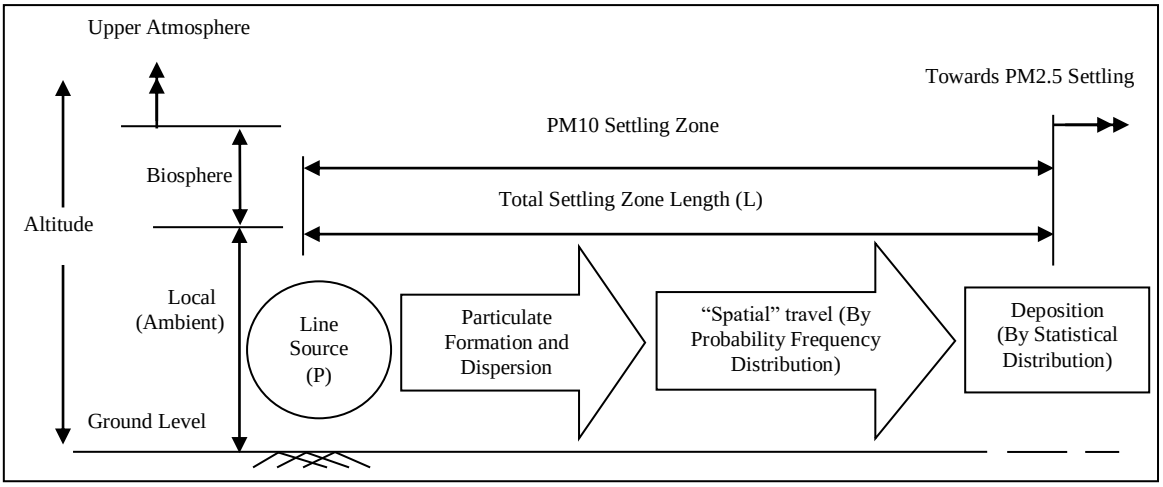


Fig. 1. Settling Zones (Elevation View)

As mentioned by Figure 1 itself, there should be an assumption to consider propagation of distribution of PM10 by a statistical way which shall be discussed afterwards. Table 1 gives the basics of airborne particulate; their behaviour and mechanism of settling. It is mentioned that the study would be applicable to any roadway/location subjected to any atmosphere/weather/climate or surrounding objects (please see Table 2, given afterwards).

Table 1. PM10 settling (some key points)

Source type	Air medium	Distribution	Settling mechanism	Atmosphere nature	Pervading settling criteria
Basics					
Vehicular	Ambient	Both horizontal and vertical	Impaction, interception, sedimentation	Prevalent	Dispersion, Distribution and Statistics

Entire study is theoretical, academic and interesting to research point of interests. It unfolds a visionary thought led by scientific finding.

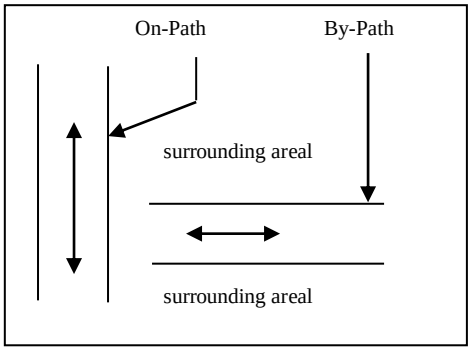


Fig. 2. Plan Layout

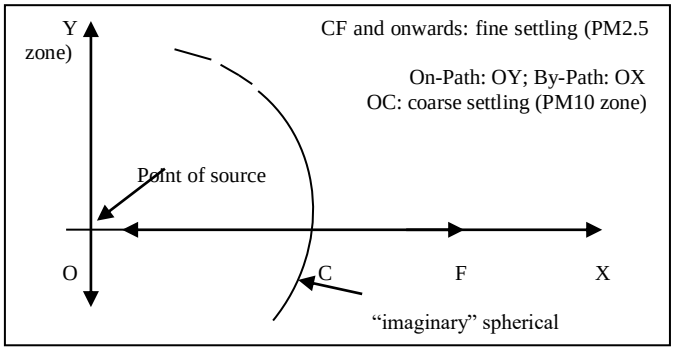


Fig. 3. 10 settling zone and imaginary sphere

1.1. Background of the study

For a given location, there should be position of main road and its bifurcated one as shown by Figure 2 (plan view). Features resting over the place that might be termed as surrounding areal should govern the nature of distribution and settling of particulates generating from source which is necessarily on the main

road (On-Path). As the study discusses kind of statistics involved in a particular settling phenomenon of particulate (PM10 only), the study considers an assumed zone within which such settling must happen in all respects. Such a zone termed by the study as PM10 settling or 10 settling zone simply can be assumed to be looking as spherical in shape (in plan-view). In an axial system, Figure 3 shows such an imaginary zone which is, later by explanation, shown with scientific reasons to justify and confirm it with realism/reality. Subjectively, OC is to be in By-Path as it is evident that OX and OY is On-Path and By-Path respectively (Figure 3). So, it is now quite clear that the study is going to narrate out settling phenomenon on By-Path by On-Path which is acting as source of PM10 pollution.
[Note: Imaginary spherical zone of PM10 can be a full sphere, all around, about its centre.]

Table 2. Basic kinetics of study

Sl.	Kinds of road-way or path	Feature	Pollution Modelling	NWZ Approach (applicable yes/no)
1	On-Path	It is main road	On-Path Modelling (OPM)	Yes
2	By-Path	It is branch (horizontal) roadway, placed at 90 degree or else, to On-Path.	By-Path Modelling (BPM)	Yes

Lots of study by their experimental data and analysis, like the ones as [21], [22], [23] and [24], show that 10 settling should happen only after PM10 has travelled down a few distance away from its source; although, distance where most concentration (PM10) is found is most important. Based on such finding, a schematic layout diagram could be drawn which provides an idea of how such settling happens (Figure 4).

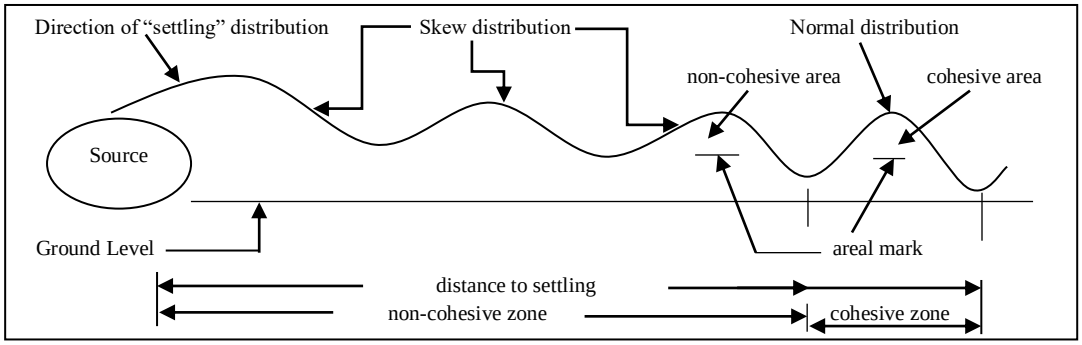
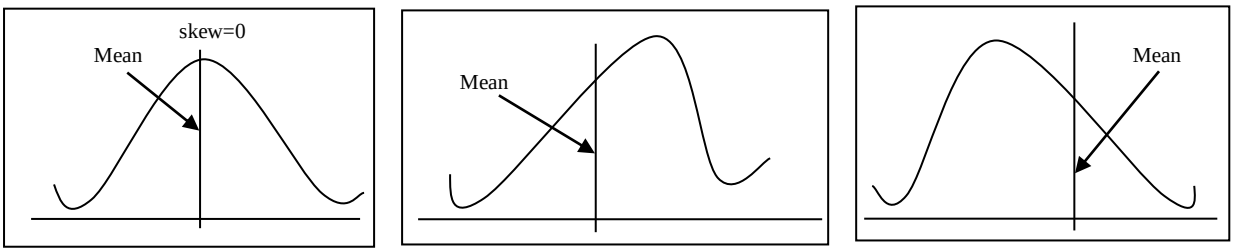


Fig. 4. Variations of statistical distribution of particles to 10 settling

All experimental data, like [25], [26], [27] and [28] including previous ones given earlier, has claimed that 10 settling should always happen by a statistical way of journey. Since PM10 liberates out through its formation in air and back by its source or else (like re-suspension etc), all kinds of statistical distribution should definitely take place [1] and final or ultimate settling could occur either by skew or normal distribution or in a combination of statistics interest[29], [30]. It is assumed that an ideal settling should happen and occur by normal frequency distribution only.

Figure 4 shows the layout perspective of settling by distinguishing two kinds of frequency distribution. The study for better understanding entire settling zone has divided into two - cohesive and non-cohesive settling zone respectively meaning to normal and skew distribution. Term "cohesive" is literally valid in the study, so as to define settling potential or assertive condition to setting of particulate pollution. And, term "areal mark", shown by Figure 4, is added to indicate the planar surface area which may, as shown, be equally meaningful to location area as well as hypothetical study-area of concern to the study.



5.1: P.F.D (normal) 5.2: P.F.D (skew to right) 5.3: P.F.D (skew to left)

Fig. 5. Various kinds of probability frequency distribution (P.F.D)

Figure 5 gives various kinds of probability frequency distribution (PFD), as an assumption of the study, that may take place in a given settling (10 settling) phenomenon; for normal PFD, skewness is equal to zero. Followings shall be considered as assumption of the study:

- The study has not mentioned an ideal settling ambience or ideal atmosphere. Instead, entire ambience is divided into ambience of cohesive and non-cohesive settling. Term “ambience” refers to an ambient atmosphere, which is from (at or near) ground-level to an ambient level of atmosphere. Thereby, an ambience is nothing but a spatial zone or area surrounding a considered or given point on ground-level.
- Cohesive settling (zone) happens in cohesive ambience that occurs only in normal PFD (Figure 5.1) and non-cohesive settling in non-cohesive ambience which is characterized by skew PFD (Figure 5.2, 5.3).
- As long as skew distribution continues, PM10 settling can never be said “happening” or “starting”. Conversely, whenever settling (of PM10) happens, it should be said that there is only normal PFD happening or prevailing. So, rational settling (of PM10) is nothing but a normal PFD which is practically possible to be set or happening at an atmospheric (biosphere) ambience.
- There should not be co-existence of above two kinds of settling ambience (of particulates), at a given time. There may be a series of such two kinds (of settling criteria/ambience) alternatively and repetitively along a settling trajectory/path of particles.

At a given location, nature of atmosphere is not so unknown, especially at ground level. This confidence is due to identity of location over natural atmosphere by primary and secondary data. Such identity is variability of the location with regard to atmosphere and its various agents like temperature, humidity, wind speed, rainfall, solar radiation, wind direction, etc etc. Subjectively, the location must be in coherence to settling privilege, which defines setting up of built up environment. So, characterization of nature of “airborne” 10 settling zone at a location or place is easily possible to have as information or guide to particulate research.

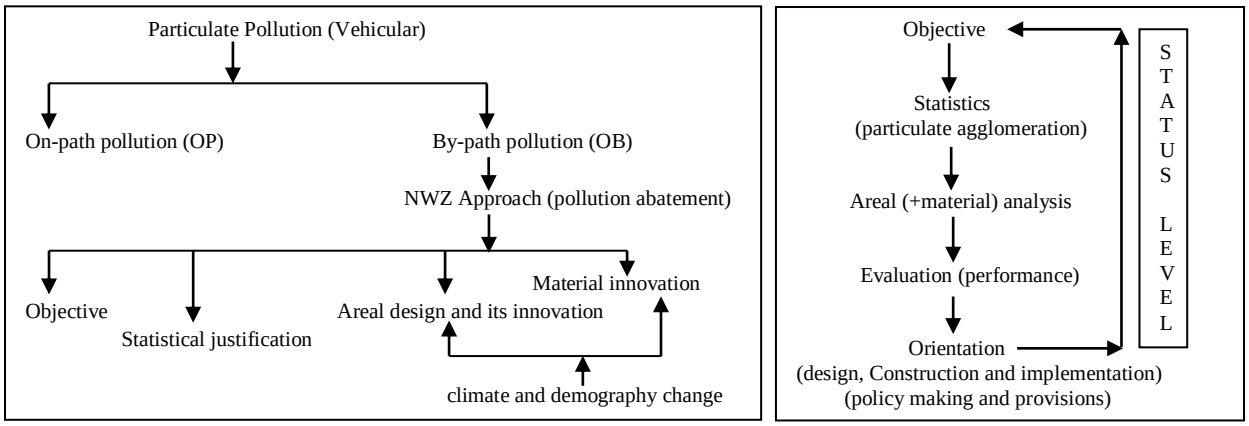
As shown by Figure 1, local (ambient) atmosphere is the concern here within which particulate settling is hereby considered to happen, occur and set in. Above or beyond this local altitude, zone called as biosphere is normally turbulent in nature and that is not usually considered in settling of particulate so far as their contribution, to its lower zone “Local”, does affect on. Above biosphere, there is the huge space which is upward and also by similar emphasis as like as biosphere onto local. So, a local “ambient” environment is to be within a human’s hand reach or a few distances that may range from human’s normal or average height to well upto five-storied building height (1.5 to 15 metre). This “above” guideline is only for a consideration of the study only, and it may well vary also.

[Note: Entire study is meant for local (ambient) zone only (10 settling) that may be subjection of other zones as well as explained.]

1.1 Methodological Initiations

In order to have a well-constructive settling zone all over at ground-level, a source (line) must be in good proportion (of volume of pollution liberation) with built-up environment and thickness of surrounding areal. Such proportion as "good" nature may often be discriminated by PM10 and PM2.5 settling zones. So, a 10settling zone (that is PM10 zone) must be studied well to know and demarcate the furtherance settling which is PM2.5 settling, and surrounding "areal" must be ordained with in accordance with this. With this, a design is consequently made up for the location of interest subjected by line source of vehicular pollution.

An approach, called by NWZ (narrow wide zone), has been applied as methodology of the study into making a cohesive nature of settling zone that would not only cause PM10 to settle but also not disturb PM2.5 settling. In applying NWZ approach, a management needs to be followed and it is also described by the study.



6.1: Methodological particulate removals (10 settling) NWZ management

Fig. 6. 10 settling and creative NWZ management

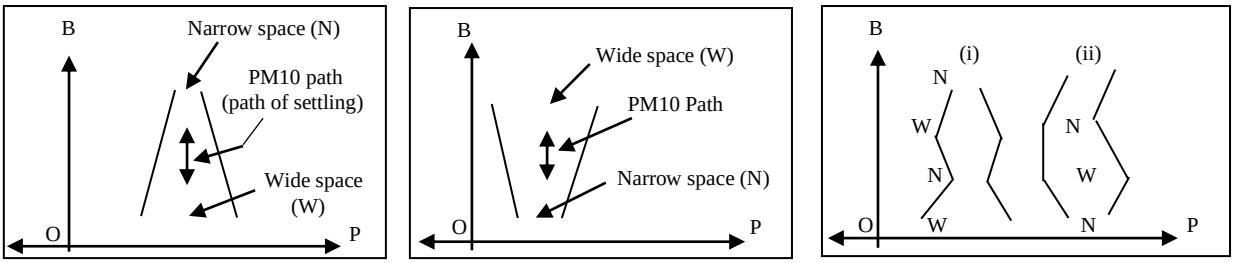
Figure 6.1 gives entire layout of methodology and Figure 6.2 shows how management of NWZ approach should work. Both the figures are self-expressive and self-explanatory to the explanation.

Table 3. Theme components of study

Sl.	Methodology (alongwith NWZ)	Background (Perspective)
1	Statistics implication of interests	Objective, Vision, Mission
2	Material innovation and design	
3	Orientation (such as Policy, People awareness, Norms/acts/rules/laws, Vehicular upgradation, Fuel quality and its combustion effectiveness, Tail-end concerns, Ecology balance enhancement, Built-up envelope and environment, Waste-to-recycle initiative and Consumption lifestyle etc)	

Table 3 gives quite a detailing of what orientations could be made up and associated perspectives to draw out such an approach and its corresponding management. It is thereby clear that NWZ reveals a "pollution"

status of a location with respect to particulate pollution (PM10) abatement. Entire study has been explained with basic aim to define and create a local ambience (at ground level) cohesive enough to particulate settling, of PM10 interest preferably. So, an ambience defined by cohesive nature of particulate (PM10 preferably) settling is hereby termed as cohesive areal modelling or CAM simply; methodology of the study explains how a surrounding area should be given a CAM to particulate pollution removal. Subjectively, CAM should also hold creativity like NWZ (Figure 7) as a part of it or the study as well.



7.1: W to N Kind 7.2: N to W Kind 7.3: Zig-zag Kind

Fig. 7. NWZ and its various kinds (along OB only)

Short note on NWZ: It is an aerial outlook (plan view). It is with an aim of creating an area of better spread-ability concern. As OB path is the pathway of our study, so the creation is to be on OB path. An area of concern can be armoured with or adorned by various covering by plantation or roofing etc so as to settle down the particulate matter like PM10 of flowing air within not very long reaches. Figure 7 has shown it. Using components of space-provisions like N, W as delineated by the figure, there could be three possibility to have such a creativity or aerial arrangement which is termed by the study as NWZ. Detail of NWZ is given against Table 6 afterwards, in methodology section. Such arrangement would be helpful not only to spread the pollutant-laden ambient air within the kind but also to settle them within shorter length in/for any kind of NWZ. Each of kinds has unique nature of feature and functions (see Table 6).

The study observes entire discussion on NWZ approaches. This means it assumes that an ambience is subjected to NWZ by a kind usually (Figure 7) and each such kind must be able to deliver cohesive settling in particular (Figure 4, 5). Again mentioned that cohesive settling is assumed to be happened by Figure 5.1 only while other than cohesive one is the state wherein all particles are in suspension with haphazard/non-settling movement as described by Figure 5.2, 5.3 earlier. So, a physical location with NWZ preparation/arrangement by built-up environment is hereby said to be under a management usually which is termed in the study as NWZ management that always enhances a cohesive than non-cohesive settling, of ambience, on human respiration concern. Subjectively, NWZ location is so designed or made up of that it propels a settling ambience to cohesive kind, on entire batch of (in-coming) particulates to it. Figure 7 has shown such a bringing on with respect to OB's starting from a given OP. Please see Table 6 for further explanations of NWZ.

1.2 Mini-Recap

Several questions that may come to behind such cohesiveness formation in atmosphere close to ground level -

- How is cohesive settling to be created?
- How far is its range (of dominance)?
- What is physicalness for it to be materialized?
- What are various fundamental theories pertinent to it, providing the confidence?

At any ground-level location, there are basically two kinds of distribution simultaneously, namely horizontal and vertical distribution or settling. Each of these distributions can be distinctly defined for a given and prevalent winds flow and other atmospheric agents/variables (like relative humidity, solar radiation, temperature, rainfall, etc) including locational features. These variables have their own concern to affect a settling, over horizontal or vertical distribution.

[Note: The study considers only horizontal distribution of particulate settling as it explains settling of particulates along a horizontal plane (OB).]

Originating from source, particulates flow and get spread over by pfd distribution which can be represented by statistical measures (Figure 5) - already it's assumed by the study also. As said by this present study, this pfd distribution can be set up to proclaim an ambience as a pre-determined or presuming nature (for a given atmosphere and its pervading location) to PM10 settling by NWZ and its management. This means a particular nature of settling (normal or skew pfd) can be thought of, accounted with and estimated based on locational feature, behaviour of its atmosphere at ambience level and concentration of "particulate" pollution.

As the present study focuses to particulate matter and its settling only, the study has assumed that particulate distribution would accumulate, spread and settle down (by gravity) by statistical distribution of probability frequency distribution function (pfd). This is interesting and objective part in the concern. This propagation upon research knowledge of statistical particulate distribution is at core of the study.

Such a statistical distribution, on horizontal settling, is highly possible at any given location or environment. So far given up by various reviews and studies (by bibliography), it might need or demand suitable and accustoming built-environment and suitable use of atmospheric agents to form a "desired" settling trend by statistics. It would enhance any locality or city to grow up to higher version of modification. This is not only to a higher version but also to be to the environmental dominance by mankind, towards creating a greener, pollution free habitation. Such an environment may be called as design environment than calling it as only built-up environment. However, such kind of design environment is irrespective of any locality of any built-up nature; it can easily be applied into rural places/locations, if not thought of them yet in this study. So, the design environment enhances landscaping, orientation, use of vegetation cover to channelize atmosphere (agents), suitable plantation (by kind also), pollution measures, policy, etc. etc.

At end of the study, the research attracts several research scopes to attain at best design environment. It is broad, engulfing by nature and seeks expertise (visionary). Such would bring in new structuring and innovation besides having an upgraded environment to the facility to human service. After all, city-life experience would be flowing through a different life-style and visionary service which is only now a thought of realization at perception level but it all in all pursuits to the new higher version of a city's grade of living.

Following are the literature surveys done and found relevant in pursuit of the study as well,

Michael L. Larsen et al. Study (2003) [31]

This is a work stating a debating research on whether rationality matches with stochastic experiment or not. The study has shown applicability of Poisson's probability distribution function and validity of it to describe correlation of dispersion in atmosphere, by it. The study has initiated three simulations – negatively correlated, positively correlated and purely random base. This simulation concept has been further justified and supported by time-scale experiments of correlation residency. Ultimate finding of the study is that it enhanced random dispersion more than implicitly independent concept of dispersion of aerosols in atmosphere.

This literature study would help find out basis of spread or distribution of PM10 aerosols where atmospheric elements are always at the variable concern as to any practical situation, in order to throw limelight on arriving at the study's objective.

Hamid Taheri Shahraiyni and Sahar Sodoudi Study (2016) [32]

It is a study which has demonstrated all previous works involved in prediction of PM10. Various studies of temporal, spatial and spatio-temporal prediction (as approaches) of PM10 are reviewed and discussed in it. It showed relative relevance to urban area application based on variety of prediction approaches. As stated by the study, Vector Machines, Artificial Neural Networks and hybrid techniques show promise for suitable temporal PM10 prediction. It summarized the approaches which has potential to the applicability of suitable approach.

The study would be suitable for horizontal transportation and settling of PM10 along a By-path road in response to On-path busy road serving as pollution source.

Jan Bitta, Irena Pavlíková, Vladislav Svozilík and Petr Jančík Study (2018) [33]

This study explained why Land Use Regression (LUR) modelling is better than Gaussian Model. The study also showed a combination (LUR-Gaussian) would be more convenient and better to serve at obtaining precision results given the fact of accessibility of more factors inclusions feasibility. LUR is hoped with to be more useful in coming years ahead in the research area to fulfill a researcher's desired pursuits.

The study is a specific to advancement possibility over core objective of spatial analysis and feasibility. There are lots of variables, some of them need to be taken care of more vibrantly and some of them as negligible ones, but conventionality should be get accepted to be changed or altered with suitable demands or initiations. This review study is one of a kind.

Objectives of the Study

Following are the targets of the study entirely,

- To draw out and explain kinetics involved in spatial distribution by PFD of PM10 on By-Path.
- To determine an approach called in the study as NWZ approach.
- To establish PM10 regime by PFD by physical happening as it occurs to.
- To bring in various scopes of research and ranges of possibility to make PM10 free areal, at a given locality.
- To provide insights to alternative ways to find out pollution concentration on By-Path.
- To explain various physical way-outs to PM10 removal.

2. Methodology

While it's discussion of natural or artificial "design" settling (of airborne particulates) in laboratory or else, there are certain things in common between the twos and that are their model forming assumptions. These assumptions do circumscribe entire functioning of the model and its principles. It might be said also that an artificial settling in natural atmosphere by naturalness could be more complex and of a hardwork, than doing the same thing in laboratory. This present research has attempted to understand settling by statistics with its intrigued approach-cum-methodology besides making artificiality in air medium in naturalness to cause settling and consequent freeness of pollutant from ambient air (subject to permissible limit!).

In the parlance by the study's interest, Table 4 gives an illustrative understanding of what statistical settling distribution can be defined over conventional finding so far in the research of particulate distribution. Table 5 provides basic fundamental ways of settling, by statistics or knowledge of statistics.

Table 4. Contrast between conventional and statistical finding@

Post since source^	1	2	3	4	5	**Kind of finding, fundamental**
Distance, meter	at source	100	200	300	400	
Pollution level and settling kind	Highest (no settling possible)	Coarse particulate zone (High PM10 settling)	High medium particulate zone	Low medium particulate zone	Fine particulate zone (PM2.5)	Conventional finding
Distance, meter	at source	50	100	150	200	Statistical finding
Pollution level and settling kind	Highest (no settling possible)	Skew distribution	Normal distribution for higher PM10 only	Normal distribution for lower PM10 only	Dispersed distribution	

@please compare with Figure 4; numerical values are illustrative and might be comparable or competitive.
^to be pointed along By-path (assumed).

As got from earlier discussion, settling of airborne particulate by statistical inference always resembles an evidence of probability frequency by normal or skew distribution. If it is not, even then it should be considered that there must be a possibility of getting it to be realized and happened in the air medium that the statistical settling does cause particulates to settle by normal distribution preferably or other modes of settling of statistics interests.

Table 5. Various (particulate) settling provisions

Settling criteria by PFD statistics		
PFD		**Hypothesis**
Normal PFD distribution	**Skew PFD distribution**	
Highly feasible for PM10 as settling by it is valid for first some meters of distance from source.	It occurs from source till normal distribution settling happens. It has been assumed that removal of particulate never happens if skew is not transformed to normal distribution. It is of two kinds - left and right skew.	It measures degree of possibility of settling (over by-path distances). It can determine settling quality at any distances.

Also, it might be an assumption of the study itself that there must be a focus of all components (inert, living things etc of surroundings at any place or location) to respond (together) in a particular definition or degree, to particulates settling mechanism by the statistics settling by PFD distribution. So, settling of particulates that are formed and spread by vehicular pollution as a source can be thought of a best combination of features of statistics and surrounding objects at a location. Such settling is termed in the study as **settling mechanism by *statistics*** or particulates removal by statistics or simply, ***statistics settling***. So, there are two unique features that must be initiated with and these include –

- areal design and material innovation
- statistics analysis

Entire methodology is hereby determined by following twos to arrive at CAM -

I. Approach to modelling – NWZ (background of CAM).
II. An application - Statistics implications (functionality of CAM).

[Note: Above second one is part of NWZ and is not vice-versa (please see Figure 6.2).]

2.1 Approach to modelling – NWZ Approach

This is a methodological initiation given in this research paper. This approach provides distinctively a particular regime of particulates to settle within 10 settling zone. There are three kinds of such distinctive "settling" regimes. However the regimes are -

- Shorter settling
- Longer settling
- Zig-zag settling

Each must be equipped with objective and others as provided by Table 6 which gives meaning and description of each one of above threes. So, this NWZ approach provides a distributional concept in above three ways where each of the ways is able to happen, create and establish 10 settling zone, rationally. It is again mentioned that each settling regime is required to be provided with other criterion (as given by Table 6) described in the following (dots shown in row 3 in Table 6, in kinds of zig-zag settling, define the continuation of such alternation or repetition, as suitably applicable).

2.1.1 NWZ Management

It comprises of various steps of working as needed into making NWZ approach a rational one. Figure 6.2 shows the schematic layout.

I. Objective

This is the item that demarcates limitations and boundary of using NWZ to further steps to use and apply modelling CAM. There must be philosophical and physical expectations from a basis of modelling application that what should be fulfilled and what should be not. This is a kind of strategy that is to be taken care of prior to further initiations to take place.

II. Statistical justification

Whatsoever locational features surrounding a By-path including atmospheric is existing, there must be a statistical distribution for particulate to follow. Settling down by such distribution is to be by normal distribution of probability frequency distribution.

Table 6. Basis of By-path pollution analysis

Sl.	NWZ Approach (Kinds)	What is it?^	Description	How to operate NWZ Approach?
1	Shorter settling NWZ	Narrow to wide (Narrow-Wide)	Narrowness is at source and wideness at distances away from the source. So, the passage on By-path resembles as narrow to wide shape of path configuration that enhances settling at shorter lengths from source.	NWZ Management
2	Longer settling NWZ	Wide to narrow (Wide-Narrow)	It is opposite of shorter settling as given above. Here, for a given settling, particulates get settled down at longer lengths as wideness enhances skewness to disperse more onto the wideness.	
3	Zig-zag settling NWZ	Narrow-Wide-Narrow-... Wide-Narrow-Wide-... Narrow-Narrow-Wide-... Wide-Wide-Narrow-... Narrow-Wide-Narrow-...	It is combination of above twos. Suitably, a better settling zone can be created that results to a zig-zag path and settling occurs accordingly at points of settling.	

^it is by line source of air pollution as it occurs spread from OP (to OB); each approach is unique and not given in a ranking.

Normal distribution should usually become feasible and rationally happening only after a certain distance away from the source of pollution, for PM10 settling. So, there should always be a skew (non-normal) distribution first and then only the normal kind in sequence, with respect to the pollution source point at any given location. Thereforth, the finding of PFD should be studied very well so that a particular location
can be assessed as accurately as possible with respect of distribution of normal and skew kind of it, that is, probability frequency.

III. Areal design and its innovation - Climate and demography change

This is the step usually to be followed after above steps like statistics, NWZ kind, and others. At this step, surrounding areal is required to be arranged, prepared of and oriented in such a way that should support cohesive settling in the zone concerned. So, it's a part of planning and design of location. Also, it should not forget, ignore or neglect valuable criteria such as sustainability, resilience, efficacy etc. including climate and demography changes while designing the location and its various features.

IV. Material innovation- climate and demography change

It should be the last step which can be thought of in simultaneous rhythm with above step of areal design. In this, various research and developmental works are encouraged to bring in innovations that are completely able to sustain the areal design to facilitate particulate settling and removal. It is such a step where imagination or virtuality becomes to a rational entity, resembling to be purposeful, working and useful.

V. Evaluation

Earlier steps must be checked to the desired objective so as to mention their success. Objective limits must be followed always.

VI. Orientation

This is the step of making locational features oriented to the evaluation standards of implementing the differential (that is, performance metric which may be equal to difference between desired and available measures). Also, various policies have to be initiated with alongwith provisions, at this step, to give a higher level of amelioration to a location status of city/town.

VII. Level of status

As shown by Figure 6.2, a better status can be achieved if more and more recycling is done, as continuously and repetitively, from objective to orientation. Subjectively, this status is for air quality (by particulate concentration). A better level in the quality is thus hereby said to be attained by NWZ management as explained in the study. So, Figure 6.2 is a layout only to illustrate how NWZ could be tken care of, to fulfil the study's objectives.

2.2 An application - Statistics implications to particulate (PM10) removal

Basic objective of the study is to determine a modelling on the basis of assumption-like consideration of settling of PM10 by statistics interest. This modelling, called in the study as CAM, is theoretical, constructive and of academic interest.

Settling of particulate by statistics' view-point of interest is very comprehensive and well applicable. Knowing behaviour of particulate ontowards settling mechanism by concept of probability frequency distribution (PFD) is naturally highly possible and can be set to an artificial built-up areal also. Such possibility has already been discussed in literature review and in the foregoing description the study explains what physical phenomena should happen on such possibility. It should be taken care of NWZ always into all those phenomena in order to make them proper in making an areal or built-up envelope free from PM10 or such control.

Already explained, on any given location a By-Path should experience settling phenomenon in sequential phases of PFD as shown by Figure 4. There could be possibility of variety settling by kinds of PFDs as given in Figure 5, but target should always be to make an areal location to normal PFD than skew one to as much as possible. Because, location or areal under normal PFD should provide better settling condition and fast removal of PM10 from prevalent air medium. This enhancement is highly required to any encroachment including By-Path of interest. Visuals like Figure 3 then might come into perspective so as to ordain an areal on likeable standard to pollution removal. Above discussion has been enveloped by one single term which is CAM (Figure 8) that is needed in taking care of an areal location competent enough to combat and dominate over air pollution dispersion. In the study, NWZ is methodology, one of the kind, given as a new one (Figure 6.2) which should be kept at core of CAM.

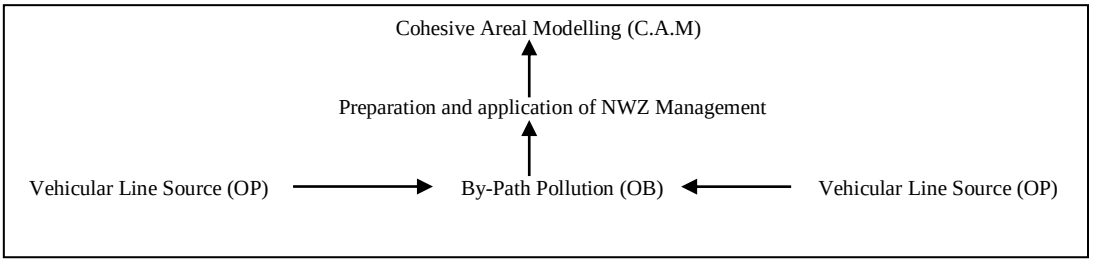


Fig. 8. CAM Layout

Usually, there are three kinds of settling mechanism of particulate. These are - inertial, impaction and sedimentation. All these threes are hereby considered to be prevailed by PFD in the study. PFD should thereby act as backbone of the three settling mechanisms. More cohesive a PFD, more degree of settling an areal location to be having - this should be made up of and is considered in the study as its prime objective. Question may be to what cohesiveness a PFD should have to be having with to govern and accomplish particulate settling! This is already explained earlier in "introduction" and again it is mentioned that simultaneous presence of skew and normal PFD would be answer of this, that is, condition of "ambient" air medium (Figure 1) may create or result to unique normal or skew PFD merely, but it should make the settling happening independent of unique presence of any one of normal and skew PFD (Figure 5). It is thereforth considered that presence of both kinds of PFD simultaneously could be also be a gateway to say that happening of settling is 100% uniquely possible for normal PFD but such is also possible owing to applicability of term "cohesive" into the study.

Note:

- For any given batch of particulates, settling transforms from skew to normal pfd, under NWZ.

- Cohesive settling can happen anywhere within a kind of NWZ. This means there could be a series of non-cohesive pfd's prior to cohesive pfd or settling.
- NWZ should assume settling of PM10 and PM2.5 both and cohesive settling should only assume settling of PM10 only (see Figure 3).
- CAM would explore out several zones of settling within OB or NWZ kinds. All such zones (like Z1, Z2 shown afterwards in Figure 15) are at a lapse over horizontal movement of particulate. Subjectively, these lapses are at change of trajectory along the horizontal movement of particulates.
- CAM would not only be deemed to be of cohesive settling only but also to enhance skew pfd to transform into normal pfd. It is all about to make a turn-on over existing skew pfd's in a given location so as to cause or happen or formulate into cohesive settling, positively and rightly.
- It is always an attempt in any built-up environment or civil engineering project to make its (project) ambience a cohesive one or transformable to cohesive one.
- CAM is a name only given to represent entire explanations by one singular terminology.
- A place or project fulfilled by CAM can be called as CAM project or CAM place.
-

I. Trajectory profile of particulate (elevation profile)

Altitude versus elevation profile of particulate concentration (on ambient level) on horizontal variability is visualized and given in Figure 9. The visualization so given by Figure 9 is completely based on rational history that what it should be and the profile would be the one like it.

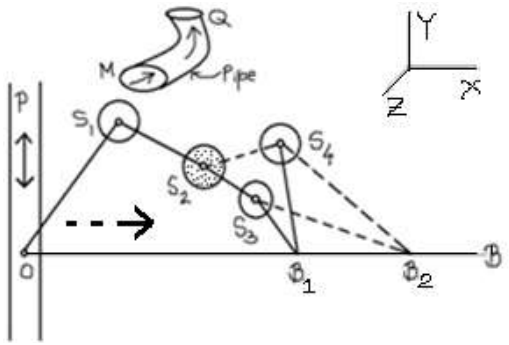


Fig. 9. Particulate settling with controlling centroid (sectional elevation; profile view)

In the figure, there are some points (in sphere) shown like S1, S2 and so on. Each point indicates the particulate concentration over its corresponding "co-ordinate" position on altitude versus horizontal distance profile as shown by the figure itself (Figure 9). The position of S2 should be at higher level as it is nearest to the pollution source and affected most by "prevailing" environmental conditions such as turbulence, fluctuations, entry or exit losses or gains, etc etc. The position of line source is O and position of settling of particulate on horizontal By-path (OB) is denoted by B1 and B2 which also signify alternative positions of settling on the path. Actually, the settling caused by statistics (normal or skew) is shown by trajectory profile in the figure by line S1-S2-S3-B1 orS1-S2-S4-B1 or S1-S2-S3-B2 or S1-S2-S4-B2. So, for a given point (B1, B2, so on) of settling at ground-level, there should be number of trajectories which might be studied as the alternative paths to settling. Another factual should be on each point that a number of points against any given point on trajectory profile should exist until finalization. For example, before going to point S3, final position of S2 at S2 should experience a number of positions around the point (S2) itself, resulting to variations in the trajectory's nature and profile. Several dots shown inside sphere of S2 indicate such points of variability that a finalization is done over all such possible dots before moving to succeeding point, S3. This emphasis of several variations over finalization of a point's position on the trajectory is denoted by encircling all those points (shown by dots) which results to resemble each point as a sphere itself. This is important so as to have the concept of variability phenomenon against each trajectory point. It reflects that

what would have been done on finalization. However, it is upto this quite clear that profile nature or concentration profiles can be shown via trajectory nature of trend or pattern that should be like the one as shown and it gives the concept of variability over "horizontal" settling of particulate.
[Note:

- Change in gradient of trajectory profile does take place due to change in PFD (from non-cohesive to cohesive or vice-versa as applicable).
- It's an assumption by the study itself that only a cohesive nature of PFD does make settling to happen along horizontal By-Path.
- The study has shown by its ownness the distance of settling along By-Path by settling length, L (of PM10) in Figure 1, by length OC in Figure 3 and by PFD by Figure 4. All these should hold equal correspondence.
- Direction of particulate settling is shown in Figure 9 by arrow mark (rightward from O to B).]

Significance of arrows (Figure 9):

- Dotted arrow from O to B indicates direction of (horizontal) movement of ambient air. As it goes forward (from O), several points S1, S2, etc do take place in the profile or pattern.
- Both-sided arrow mark indicates the roadway OP which is regarded in the study as pollutant generating source.
- A pipe MQ with inner arrow marks shown above the profile has been explained afterwards.

II. Distribution of PFD

As each of points S1, S2, etc are spatial or spatially variable, their positions should be of a number variety. On projecting of sectional profile view (Figure 9) by horizontal plane, three kinds of views are obtained and shown in Figure 10. These views depict the possibility of formation of points, S1, S2, S3 etc. on spatial interest of areal. The three kinds are as follows –

- Collinear (where all points lie on a single line; Figure 10.1).
- Zig-zag (where all points lie in an alternative way; Figure 10.2).
- Mixed (where a mix of above twos are present; Figure 10.3).

Each above variety can be called as kind of distribution of PFD. Term "distribution" of PFD is applied to indicate and define how statistical distribution (PFD) is dispersed or distributed on spatial arena, to particulate settling.
[Note:

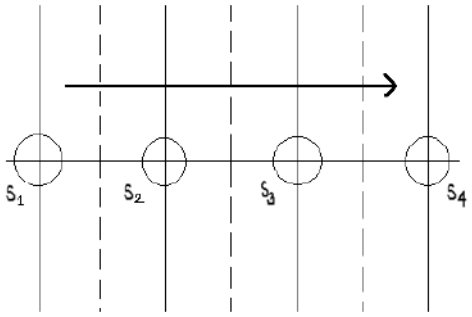
- All kinds are subject to equi- and non-equi-spaced.
- Vertical dotted line shows boundary.
- Vertical firm line shows settling point (S1, S2 etc) at intersection with horizontal line; it also indicates transverse direction.
- Horizontal line shows reference line or By-Path or like that can act as to define settling by spatial character as it belongs to.
- Direction of settling is essential to be shown and have in information to analyse always. All kinds should be under a specified settling direction of particulate (shown by arrows in Figure 10).
- All kinds should be under cohesive settling with respect to settling objective.]

III. PFD Classification To Statistically Distributed Pollution

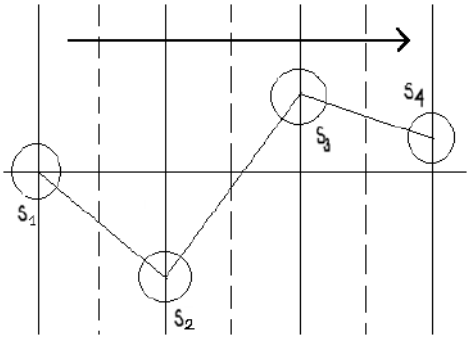
Here is the classified kinds of the particulates distribution on spatial interest (shown by Figure 10 which is in relation to Figure 9) described in this section by the following.

Collinear distribution of PFD

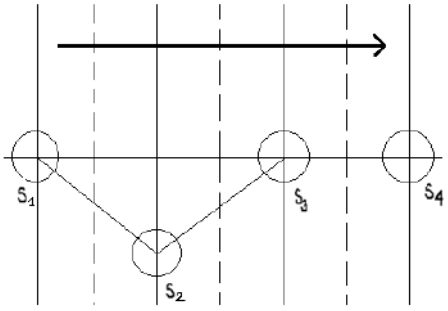
It is the kind signifying residing of all settling points (defined by PFD) on similar "horizontal" line.



10.1: Collinear distribution



10.2: Zig-zag distribution



10.3: Mixed distribution

Fig. 10. PFD distribution (plan view)

Zig-zag distribution of PFD

It is the kind signifying residing of all settling points (defined by PFD) not on similar "horizontal" line, but on different position as applicable by spatial movement of settling. Points of settling (S1, S2, etc) lying on this distribution may not necessarily lie on similar (horizontal) line.

Mixed distribution of PFD

It is the kind signifying residing of all settling points (defined by PFD) on a mix up of collinear and zig-zag distribution together.

IV. Area of influence

This is marked by dotted (vertical) line. For a given point, there should an area on both side of it which should be under maximum influence for the point itself. This influence is about settling intensity or areal

settling about concerned point. It indicates the area (or volume) responsible enough for determining a settling point. An influence area does have only one point of settling on its adjacent (transverse) line. Figure 10 shows it.

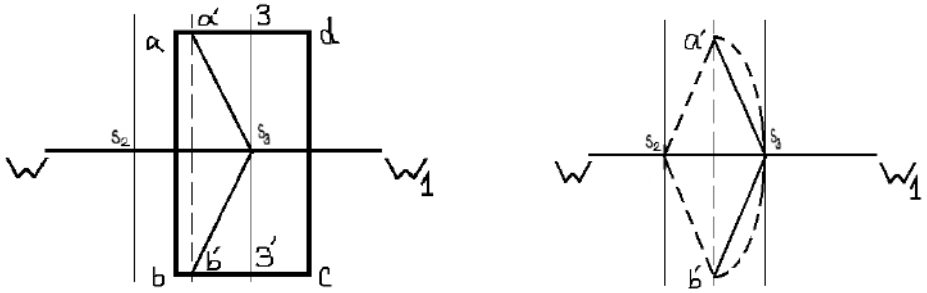
[Note:

- An influence area is formed once a succeeding settling direction is achieved or started with respect to the area itself.
- Each point of settling should have influence area on both side of it (Figure 10).]

V. Curvature of arc of settling

It is an assumption by the study itself that distribution of PFD at any instance of time does take place about a centre over horizontal projection (of Figure 9) or areal region. Such distribution is hereby visualized as a curvature of circular arc as periphery of the distribution itself. For example, for S2 there is a curvature with a centre at S2 forming succeeding point S3. So, area enclosed by peripheral arc with radii at centre S2 is to be an influence area within which PFD is getting distributed (over its best potential).

For a given area or volume of settling of particulate by PFD, there should be movement of settling along resultant path (assumed) shown by Figure 11. Example, for a given area (or volume of particulates, rather than air medium) of abcd or specifically area a′b′3′3 (Figure 11.1), settling should occur along a resultant path (assumed) which is a′S3 that is obtained by resolving horizontal (a′3) and vertical (a′b′) component. Point a′ is to be taken from line (dotted) marked for influence area. Similarly, b′S3 resultant should be found. In this way, one side against a given point (for example S3 here) is obtained with the resultant lines forming a tripod whose three sides are a′S3, b′S3 and S2S3. Such tripod should be achieved on other side of the point S3 similarly. So, line 3-S3-3′ should act as mirror to be giving another tripod on the side. Keeping changing concerns depending on kind of PFD distribution as explained by Figure 10, the point S3 should have to be determined (as a part of tripod) on best application of knowledge and suitability.



11.1: Tripod determination by resultant 11.2: Initiation of arc and centre

Fig. 11. Birth of curvature of arc

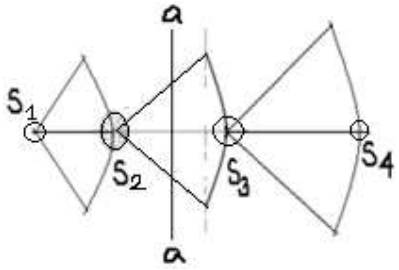
Circular arc can be drawn with the resultants on each side of the concerned point (say, S3) on settling trajectory. Through point a′, S3 and b′, an arc is hereby plotted with centre at S2 (Figure 11.2). This centre point may be elsewhere apart from S2 for given curvature. The study has explained its all discussions based on S2 as the centre point of curvature of arc. This curvature or arc should have several research scopes to proceed with find out further fundamentals on the research.

[Note:

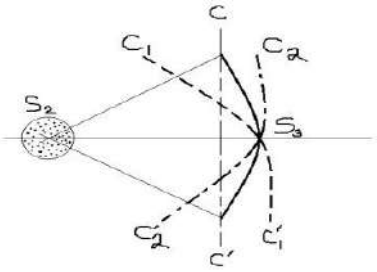
- Horizontal line (WW1 in Figure 11) should be preferably a kind of “reference” line and position of points S1, S2, etc should not necessarily coincide with a “reference” definition of the (horizontal) line WW1. This would be found true for zig-zag and mixed PFD distribution apart from collinear distribution only.

- For a mass or batch of particulates, it is assumed that settling or transformation to cohesive settling should follow a resultant path. Thus, a'S3 or b'S3 is obtained.]

Sectoral forming by curvature of arc with a chosen centre point (say S2 for arc at S3) should represent concentration areal given by a given distribution of PFD. Figure 12.1 is thereby modification over Figure 9 in place of Figure 10. However as said above or earlier that a centre-point location may be elsewhere apart from chosen S2 for explanation purpose here and there should lots of several other points (shown by dots inside S2) that could have formed prior to finalization for point S2 at S2. Again it's thereforth mentioned that presentation of point (say S2) by encircling all the dots by a big sphere is only for understanding purpose of one point to be in the concern out of several points shown by dots. In this way, curvature-cum-sectoral alongwith a single point (S1, S2) out of all dots against the point itself is obtained to define how and what should the pollution distribution and consequent settling for a given PFD distribution.



12.1: Settling zones (with tripod and arc)



12.2: Variability in settling zone

Fig. 12. Planar view of settling zone

Figure 12.2 shows how curvature would look like if its centre-position is changed instead of point S2. In the figure, curvature cc′ is only for point S2 as its centre point and similarly curvature c1c1′ and c2c2′ is respectively for centre-positions other than S2 point or position, keeping in view of concept of line WW1 as given earlier. Also, it's not necessary to intersect all the changing curvatures through one singular point S3 as shown in the figure which is instead should change as applicable. With all these variations and possibility, the explanation of Figure 9 is hereby achieved by the concept of what should be a PFD distribution should be having with while settling happens or particulates move through airs of By-path. Also noted, sectoral formation may be given by concept other than "resultant" interest.

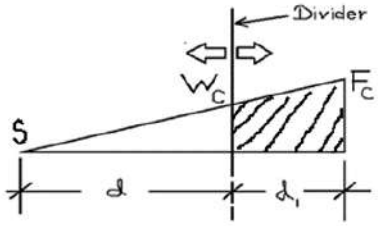


Fig. 13. Concentration triangle profile (section a-a)

Now, if a section a-a of sectoral formation (shown by Figure 12.1) is taken then sectional elevation would be one shown in Figure 13. By equating similar triangle application of geometry, we get,

$Wc/d=Fc/(d+d1)$ . . . (Eq. 1)

where,

S=S2 point of settling (it may be S1, S2, S3, etc as considered).

Wc, Fc=pollution removal status or concentration of pollutant or percentage of distribution of PFD at d and d1 respectively.

d=length of non-cohesive zone=distance of non-settling zone.

d1= length of cohesive zone=distance of (cohesive) settling zone.

Furthering Eq.1, we get,
Wc/Fc=d/(d+d1)
Fc/Wc=(d+d1)/d=1+(d1/d)

Again, Fc=(Wc)[1+(d1/d)]
Or, Wc=(Fc)/[1+(d/d1)] . . . (Eq.2)

Thereby, unknown variable can be suitably determined on given known ones by Eq. 2 using Figure 13. Furthermore, research scopes may increase to more dimensions of finding if three-dimensional features of "elemental" nature are taken care of as shown in Figure 14 by considering thickness (t) or such. So, transverse contribution of PFD distribution (with respect of By-path) may be future scope of research which could be solved and explained by this study.

[Note: L (as shown in Figure 1)=d+d1=settling zones length (total); Wc/d=Fc/L (by using Eq.1); please see Figure 21 also, shown afterward]

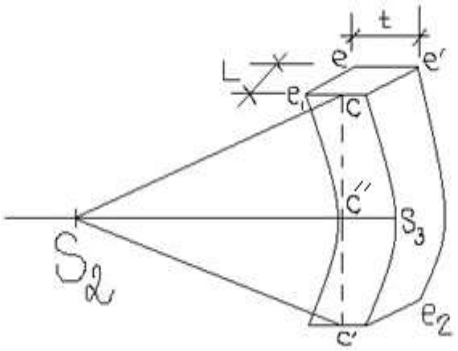


Fig. 14. Dimensional view of area of settling (elemental)

By superimposition of concept of curvature of arc and elevation profile of concentration of PM10, we hereby get the profile view shown in Figure 15 in which settling points S1, S2, etc should form their own settling "horizontal" length such as Z1, Z2 etc – as always in the study, it's just an illustration though but it should find the place while modelling on the study.

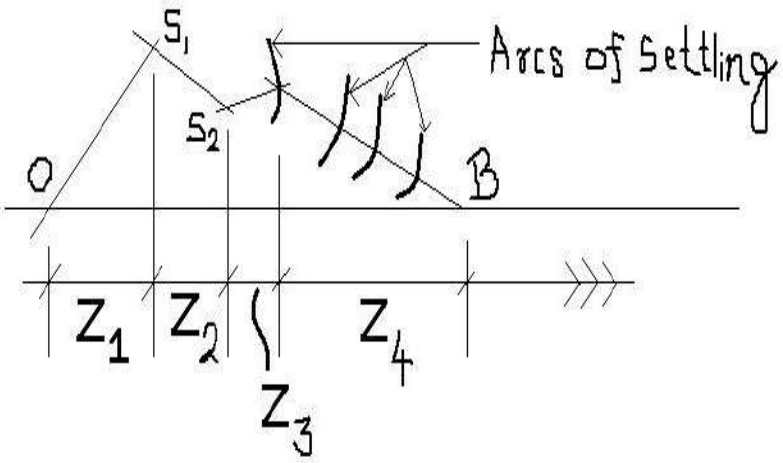


Fig. 15. Various kinetics under superimposition of arc and elevation profile

It is now clear that considered path of settling as resultant one as explained by a′S3 or b′S3 (Figure 11.1) should undergo the travelling of particulate or trajectory, by PFD distribution for settling as suitable out of normal or skew ones (shown in Figure 5). Finally, determination of points S1, S2, S3 etc should be obtained by "resultant" concept which may also be otherwise for point of interest of research.

VI. Concentration cylinder

This is an outcome of the study based on its explanations. A small curvature of arc is a part of full complete sphere. With respect of each settling point S1, S2, S3 etc we can thus have number of full spheres resting in consequence or sequence. One such view is shown in Figure 16. Irrespective size of sphere, it should resemble as a cylinder on elevation projection for a given elevation or altitude. Height of cylinder should be the height PFD has undergone or experienced during settling journey along the trajectory. This means the height of falling of settling through its various possible settling distributions of PFDs. This concept of cylinder formation should thereby be visualized as resting on connecting lines in between two points of settling successively or in a sequential manner in the consequence. Such cylinder is hereby termed as ***concentration cylinder***. So, against each point of settling there should be a cylinder consisting of number of circular plates resembling as one full cylinder entirely. Let's call each plate in circular shape by term ***"planar plate"*** (or ***settling sphere***) of concentration cylinder. Its size or dimension is of variable nature, depending on (horizontal) range within which cohesive settling does occur. In a setting of urban's built-up, such a cylinder would behave like an indication of a pollution/particulate free zone instead. As said always, NWZ management would constitute such a cylinder to process through to make an ambience pollution free. In order to ensure such a cylindrical concept, various pollution measuring experiments (for PM10 or PM2.5) can be carried through which are beyond the scope of this present study as well. Furthermore, this study can be thought of for constructing various other pollutants, be it gaseous or particulates.

[Note:

- Hatch portion shown in plan-view of Figure 16 is the areal formed by curvature of arc (that is tripod) which may extend to any extent (included angle (say at S2 for S3) should vary from zero to 360 degree) as explained in Figure 11.1.
- Shapes of planar plates may vary, to other geometrical shapes as well.]

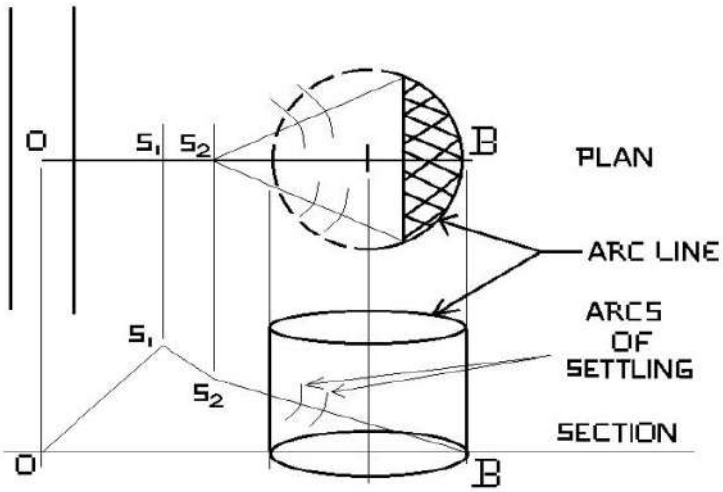


Fig. 16. Projected views with perspective of (planar) settling – concentration cylinder

A perspective view to justify above concept of cylinder formation is hereby given as follows –

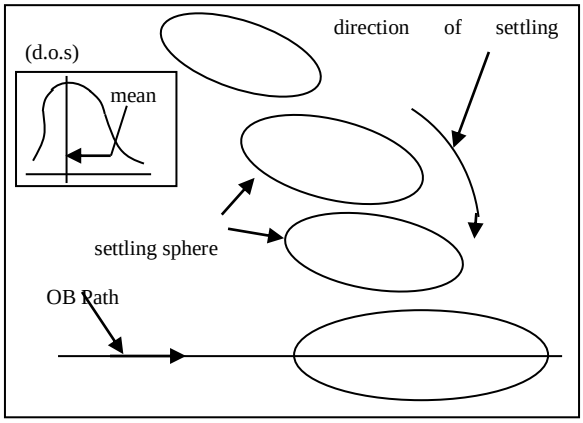
Apart from normal PFD, for two kinds of skew condition in PFD there should be different phenomenon into particulate setting by nature. For left-sided skew whose PFD is shown in inside box of Figure 17.1, each circular plate (planar plate), comprising of distribution of PFD indeed, may keep falling alongside by keeping its balance over its "left-sided" skewness of PFD. Tendency to opposite side (that is rightwards) is due to making a normalcy in the PFD distribution. Moment is also thereon acting on such rightward settling of left-sided skew and that should be clockwise (upside convex). It is shown in Figure 17.1. For right-sided

skew, phenomenon would be opposite as normalcy is on left side and skew is to rightward (Figure 17.2) and in this case ***"direction of settling"*** (d.o.s) should be clockwise with upside concave as shown. This is only an illustrative explanation delineated for understanding of the concept for the study.
[Note: Depending on prevalent ambient atmosphere and others, direction may be clockwise or anti-clockwise (not in sameness but also in opposite manner) and criteria or concave or convex may also change accordingly.]

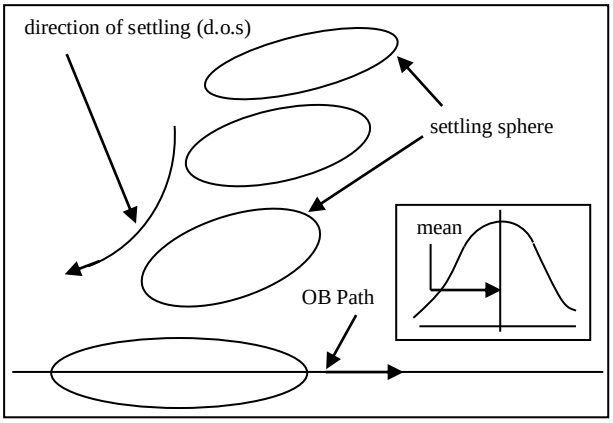
Now, we can also imagine that such falling of settling spheres may occur through a channel based on the skew that holds (Figure 17.3). And, finally the cylinder consisting of plates is formed at the point of settling at ground-level which is shown in Figure 17.4. It may be infinitesimal by nature but it's the research concept for understanding. In this way, the justification of formation of concentration cylinders is explained to defend such determination by resultant concept of tripod and curvature of arc earlier as given by Figure 16.

VII. Concept of transverse settling and settling field

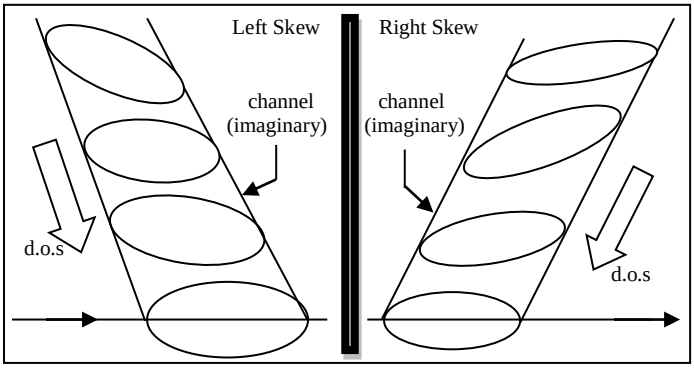
It is noteworthy to imagine an areal surrounding by the concepts discussed earlier in this study and it should provide idea of settling character of PM10 interest.



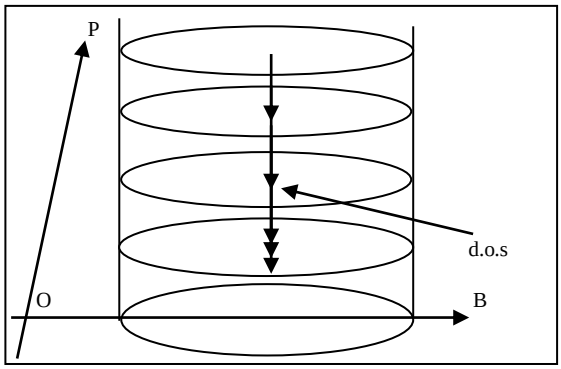
17.1 Settling by skewness to the left (clockwise)



17.2 Settling by skewness to the right (anti-clockwise)



17.3: Skew and planar plates



17.4: Concentration cylinder with beads

Fig. 17. Evolution of concentration cylinder (in particulate pollution removal)

Transverse settling

It's already got indication in explanations of settling kinetics given earlier. For an areal surrounding, settling of PM10 is completely possible to at any desired location along By-path away from On-path provided a design scenario is made by policy and etc (Table 3). The study so far explained can be easily put

on in any given By-path locations irrespective geography and demography. However, a simple plan view can show how a transverse variation could be formed using the study's concept. It is shown in Figure 18.1 where a number of curvatures are possible and to be considered for the analysis, subject to any required changes if necessary.

PM10 free field

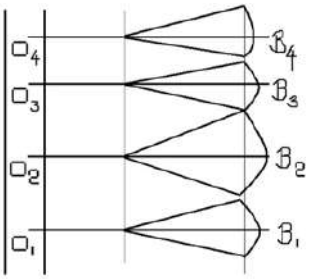
It is customary to have a field once more than one number of By-path meet at a single point together. Figure 18.2 shows it for such four in number. Enclosed area formed by several curvature of arc together, on outside of each By-path, as shown by the figure is hereby called as ***10 settling free field*** or ***PM10 free field***. The field which is formed on outside of each By-path in a set of number of By-paths meeting together may be in subjection of either or both of following twos –

- PM2.5 zone.
- Zone free from PM10.

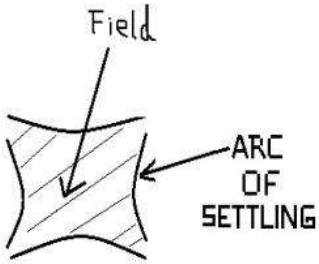
Such field having PM10 free definition may have several following benefits –

- A field from PM10 may be suitable for hospital, hermit, crèche, heritage building, parks etc.
- Dedicated built-up envelopes may be given on the field for removal of PM2.5 interest.

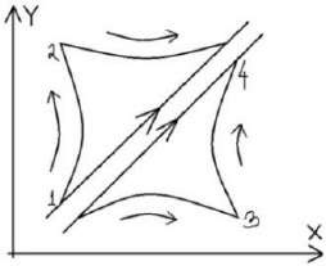
[Note: Term "envelope" defines to ambient stability in response to prevalent atmosphere.]



18.1: Arcs forming "sectoral" (plan view)



18.2: A 10 settling free field



18.3: Vectorial presence in the field

Fig. 18. Transverse sectoral and peripheral boundary of settling surrounding a field

"Singular" field direction (of pollution flow)

A field of settling is defined as, settling field at a given locality=sum of (multiple settling zones).

It is possible to determine a direction of pollution flows for the field stated above. By vectorial application simply, all sides by defining or representing as vectors direction of "resultant" can be obtained which should be the direction (of pollution-flows) of the entire field.

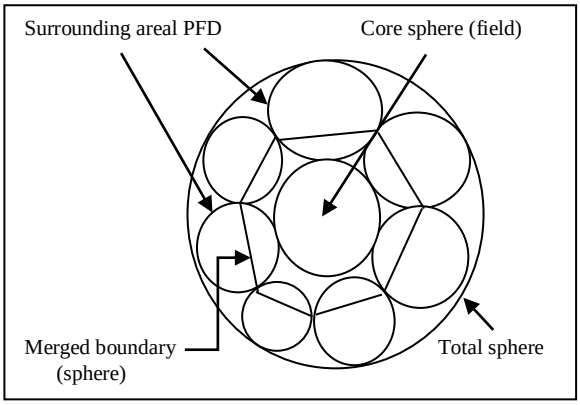


Fig. 19. Merging with adjacent spheres

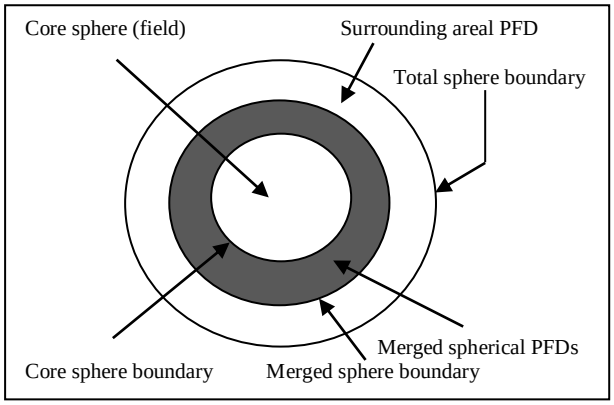


Fig. 20. Evolution by clarity between core and merging

Figure 18.3 depicts it and resultant direction is shown By-path 1-4 (here it's assumed as 1 to 4, for both the triangles, which may be otherwise depending on given conditions) for given vector triangles 1-2-4 and 1-3-4. This is completely illustrative and all directions are given for understanding purpose for given finding by vector analysis so shown in the figure. So, this may be the way of determination of direction of flow of entire field.

[Note:

- Above summing is subject to variability and its viability to function as a singular field.
- "Field" is defined in this study as PM10 free zone.]

Total "field" sphere and its boundary

This concept can be made in either way of inside to outside or outside to inside at a given locality of settling consideration. As envisaged in previous delineation of forming up a ***"singular"*** field, there should be a development of several number of settling zones joining together in any way (along tangent of "settling zone" sphere or else) resulting to appearance of number of spheres connecting one by one on a spherical field. Figure 19 shows it where number of spheres concerning to their PM10 settling zones should be found together for a given locality or surrounding areal. If periphery or circumferences are joined by a straight line or sphere there should be two spheres, one on inside and other on the outside, For such a figurative understanding, we should get an easy deliverance about phenomenon happening at locality where number of By-paths may be analysed together which are considered to be such as shown in the figure. Outside sphere which is called as total sphere should be an extreme boundary of settling zones and analysis, whereas inside sphere that is termed by core sphere should be treated as the field explained by above segment (also please see Figure 20).

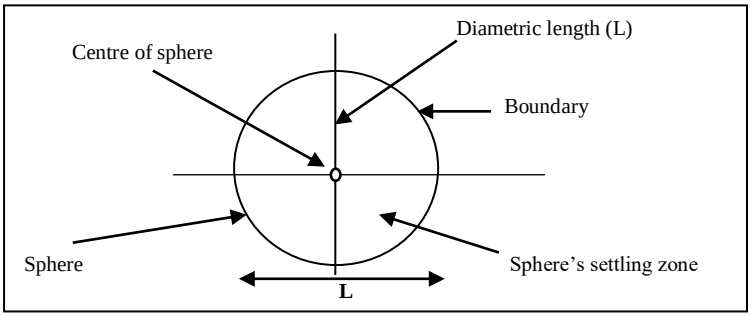


Fig. 21. A typical "settling zone" sphere (plan view) of diametric length L

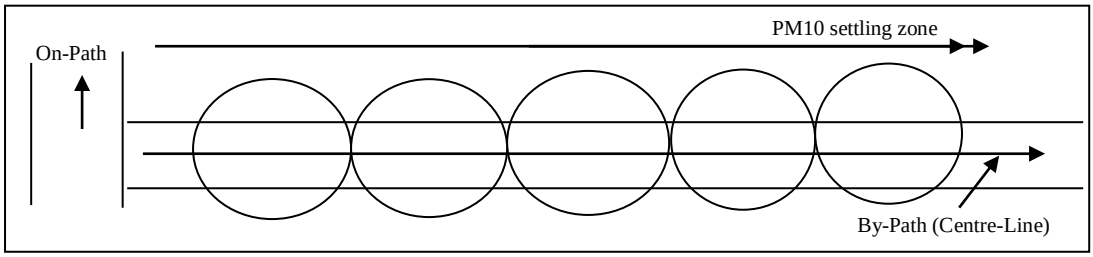


Fig. 22. Ideal network of spheres

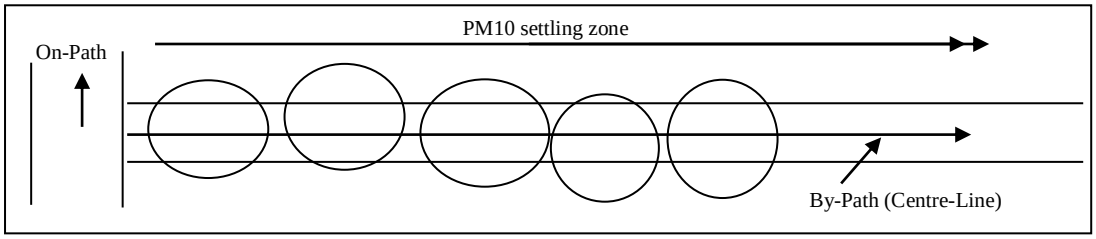


Fig. 23. Real network of spheres

It is quite well known that every consideration where a circular or curvature of arc has been initiated with in this study can be also analysed by straight line initiation. Merged sphere zone which is between total sphere and core sphere zone can also be found by curvature of arc or curvature simply instead of straight-line initiation as shown by Figure 19 and Figure 20.

As all geometrical shapes are shown in the study not to scale so areas coming out from related analyses or figures should be considered as relevant to rational happening as there is no defined geometrical consideration that can be put on in the study as of now.

Figure 21 shows what elements of geometry one sphere of settling zone interest must be having with by keeping all considerations as changeably constant as always in the study.

PM10 Settling Length

It is the distance from source where PM10 is considered to be get settled down at ground-level (Figure 1). A typical settling zone should have its settling trajectory over several spheres of "considered" PFDs. Such spheres may be imagined as shown in Figure 22 and Figure 23 in their plan-view of formation for an ideal and rational perspective respectively. So, it is at well disposition of knowledge that all these spheres which represent various forms of settling by PFDs could be represented by a single or big sphere (Figure 21) in which all those several spheres might be situating as well.

VIII. Pollution physicalness abatement (Impending Tubule)

It is observed from the study itself that there should be an outset of innovation above a certain height from ground-level to reduce ambient PM10 concentration. With this purview, a tunnel or pipe could be kept at an altitude to attract and drag out PM10 from ambient air to outer atmosphere). Figure 24 shows kinds of pipes that can meet the criteria by their shape as required (H1=height above ground-level; H2=height of pollution removal, that is, height within which the pipes would be kept or spread). For relevance, Figure 1 can be compared here.

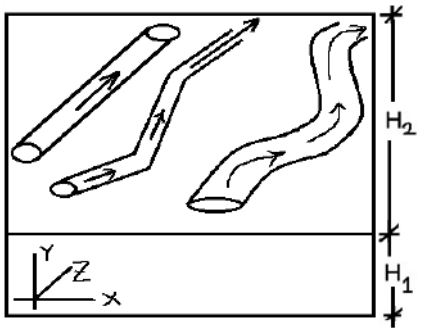


Fig. 24. Different impending pipes in the height

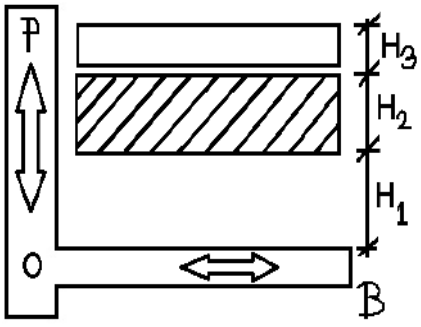


Fig. 25. Impending heights (3-dimensional)

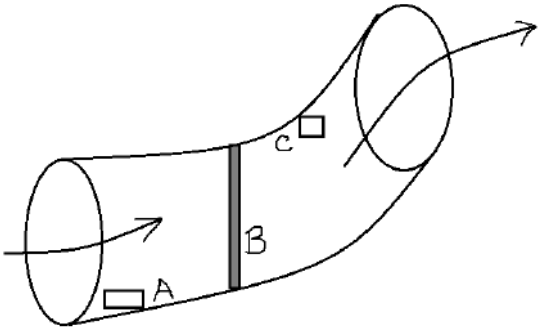


Fig. 26. Impending Tubule or Pipe

(air-flow direction into pipe by arrow: left side: entry; right side: exit)

Figure 25 is hereby given for having a distribution of heights for laying the pipes. H3=height of biosphere as suggested by this study whereas H2 should be given for giving the pipes' laying and H1 to be a (clear) height above ground-level. Such innovation is termed here by "impending pipe or tubule".
Figure 25 is hereby given for having a distribution of heights for laying the pipes. H3=height of biosphere as suggested by this study whereas H2 should be given for giving the pipes' laying and H1 to be a (clear) height above ground-level. Such innovation is termed here by "impending pipe or tubule".

Figure 26 gives an internal layout component to delineate functional working. A=motor (battery/solar/electrically operated); B=filter membrane; C=exhaust or exit fan. Impending tubule which should be kept at a suitable inclination should be operated by motor to channelize ambient air (pollutant) into its own internal path or bends through suitable filter medium to separate out PM10 and finally release out PM10 free air with an enhancement of exit fan.
[Note:

- Subjectively, Figure 9 is also shown with an arrangement of such tubule (MQ pipe) just above the profile variation.
- Heights, H1, H2, H3 are research points of interest.]

IX. Physicalness preparation (on transformation of non-cohesive to cohesive settling)

There should be possible to design a built-up envelope in an areal surrounding (termed in the study as surrounding areal) concerned By-path and to do this, Table 7 is hereby provided to define how such an approach could be done to make and prevail a certain level or status of PFD by implying emphasis on associated attributes of possibility.

Table 7. Innovation provisions to cohesive areal modelling^

Sl.	The study	Modelling's theme steps	Physicalness provisions on statistics conversion	
			From	To
			Skew or non-cohesive distribution	Normal or cohesive distribution
1	CAM Modelling	Areal design (anticipating)	Orientation (building, road, drain, boundary wall, etc.)	
2			Landscape design	
3			Cohesiveness (Atmosphere)	
4			Hollow passage (hot air path/layers surrounded by cold airs)	
5		Provisions and Preventive	Colder passages or bushes at ground-level or at altitude as suitable	
6			Sticky smooth, glassy or wet surfaces	

7		Materials	Wind velocity reducers (obstruction, barriers, curtains, shrubs, cripple plants)
8			Altitude pipes and glossy (Figure 26)
9			Anti-reflective material (absorbers/adsorbents)

^with NWZ planation and many others of innovation interest and creativity.

2.3 Assumptions of C.A.M

- Settling is best possible and accomplished by normal distribution of statistical probability frequency function.
- Source of pollution is vehicular of On-path and settling of the pollution (particulate only; PM10) on or along By-path is the subjective interest if research and discussion.
- Particulate of interest is PM10 only.
- Boundary of settling is circular by shape. This means each settling zone is of shape of sphere or circular sector or area under circular arc.
- Area under settling is assumed as an imaginary sphere which may or may not have equal settling condition in all its directions So, it's only a sphere presented by a settling arc in the settling zone.
- Settling zone is called for settling on By-path only.
- It is considered that coarser particles (PM10) would settle first and then finer ones as we go away from source location of On-path.
- By-Path's particulate settling of PM10 (not PM2.5) is only the study point of interest in this study.
- It is considered that origination of settling condition shall take some time or distance to settle or removal finally; removal means removal from atmosphere. This means that there must be a distance or time interval between origination of settling condition and its final settling in a particulate removal process of By-path. This is one of reasons behind settling arc or arc nature or shape of settling boundary.
- There may be a distance in between two settling arcs. This enhances study of lateral distribution of particulate settling.
- Negligibility can be assumed as applicable to anywhere as suitable validly.

3. Results and Discussions

- Dispersion or distribution of particulate (PM10) is discussed with sharing of particulate between By-path and On-path respectively acting in the study as affected by pollution and source of pollution (vehicular line source).
- Entire study is explained in limelight of horizontal distribution of particulate.
- Distribution by PFD is already an established fundamental. The study has explained its various insights on physical and perspective ground.
- By magnitude, d and d1 can have three possibilities and these are as per Eq.2 and as obtained as follows (please see Figure 13) -
    - d=d1
    - d>d1
    - d<d1
- NWZ approach is one of the innovations the study's given in the pursuit.
- There are various scopes of materials innovation of application which should include -
    - Impending Tubules or Pipes (with motorized arrangements; Figure 26)
    - Sticky Bars (curtains/pads/sprays) – the location's surrounding objects to be covered by glue-like matter that can easily attract and stick up PM10 particulate.
    - NWZ Plantations – greenery can be put on by NWZ definition at the location of By-Path site.

- More understanding and further research is possible over explanations of the study so made.
- The study's claimed that normal PFD is possible to create or prevail but more of it, "cohesive" should be the term to express the functional purpose of that.

4. Conclusions

- Initiations of several new approaches have been provided in the study.
- The study, by its entirety, could be resembled as a modification over inclusion of various perspective based concepts subject to rational validity.
- From curvature of arc to concept of field and its direction is a completely new part of the study as well.
- Furthermore, cylindrical settling areas should excel more other research pursuits with respect to "changeable" creativity or further new parts of the study.
- With entire explanation so found out, the subject of particulate settling could find broader dimensions ever.
- Several physical measures could be provided to abate particulate pollution and this includes PM10 post marking, PM10 Impending Pipe, NWZ Plantation, human awareness to use mask always etc etc.
- It is possible to make demarcation of PM10 settling at ground-level. Figure 27 shows a layout to showcase total or final settling point (T) of PM10 to define an entire settling zone of PM10 for the given source O as shown.

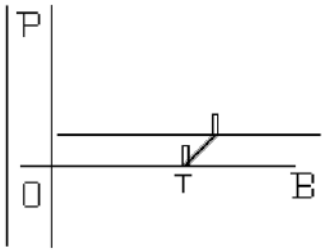


Fig. 27. PM10 post (T) on By-path

- A sketch of NWZ and its various kinds has been shown in Figure 7. Arrangement of N or W should be made within a settling zone not necessarily defined for PM10 only. However, cohesive settling zone for PM10 marked by OT of Figure 27 indicates PM10 free zone to TB. This kind of showcase shall have various implications on beneficial ground and those might include as,
  - Social and health awareness.
  - Value or status of the location.
  - Implications of engineering and science.
  - Correlative effect with involved structural or environmental components (such as drains, vegetation covers, boundary wall if any etc.).
  - A field of importance.
- The study proclaims that instead of normal distribution only a combination of all PFDs (which is termed by cohesive zone of settling) could be the best spatial distribution of PM10 in ambient atmosphere.
- Other introspections should include -
  - Basic precautions, like [34], [35] and [36], must be attained at while creating modelling on the study as explained.
  - In another perspective, approach like [37], [38], [39] etc may give spatial variability to understand.

- The study is equally applicable and quite of highly enhancing also for the study like [40] and scale-based barriers must be always in great concern like [41].
- The study could vary or modify available practices of greenery in and along road-side pollution concern as studied for [42] and [43].

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