Estimation of Adverse Effects of Demolition: Dust and Vibration

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Abstract **- In the construction world, the number of structures with various aspects and purposes as their requirements & demands of the infrastructure of the city or town are constructed and demolished. As the time passed, the life cycle of builded structure is going to over as per design, or illegally constructed. We know that every structure is designed for a specific life period, generally 100 years. The existence of the structure after the service life period is very dangerous to its occupants and surrounding buildings. The hazards during demolition are falls, being struck, or buried in falling material or by the unintentional collapse of the structure, noise, vibration, and dust. In addition, workers may be exposed to hazardous chemical and biological agents. Therefore, it becomes essential to demolish the building. Demolition is the tearing-down of buildings which involves taking a building apart while preserving the valuable elements for re-use.**

There are various methods of demolition. The building is brought down either manually or mechanically depending upon the method used for demolition of buildings. Equipment's used for demolition work are hammers, rammers, excavators, bulldozers, wrecking ball and the explosives used are dynamites and detonators etc. which is generally preferred for tall buildings. The various steps involved before the demolition process includes surveying of the demolition site, removal of hazardous material and safety precautionary measures. The study also includes the precautionary measures regarding machinery or equipment's, scaffolding, public safety and worker safety.

Index Terms **- Demolition, Negative impact of Dust, Negative impact of Vibration, Demolition area study, Safety measures.**

I.INTRODUCTION

Demolition is the process of destroying down or dismantling or collapsing down of large buildings after its useful life period. The process of demolition is carried out with the help of some equipment or other methods with legal procedure followed by the consent of the local authority. We know that every structure is designed for a specific life period generally 100 years. The existence of the structure after the service life period is over is very dangerous to its occupants and surrounding buildings. The purpose of demolition is to prevent the accidental collapse of any part of the building and to ensure safety of workers, public and neighboring properties. Prior to carrying out any building demolition, detailed building appraisal by means of surveys and appropriate assessments shall be required which shall include a building survey and a structure survey.

The purpose of the assessment is to provide information on the potential sources of vibration and dust that may arise from the demolition of the existing buildings and the construction of the new development together with recommendations for mitigating or preventing potential nuisance. All construction companies are required to operate their sites in a safe manner to minimize disruption and inconvenience to local residents, businesses and wider local community. Many of the major causes of complaints on construction sites are related to noise, dust and vibration from on-site operations. Therefore, monitoring and recording the impact of noise, dust and vibration from your project is essential to:

- Comply with planning conditions
- Prevent or help resolve complaints from local residents / businesses
- Protect against claims.

II INTRODUCTION OF DUST

There are number of activities running at the demolition site to dismantle the structural member of buildings regarding to their own approach. Therefore,

as the reason of these different activities by using different techniques and method of demolition, the dust suppression occurs with uncertain amount and hazardous risks. Dust includes various particulate matter which are different in their sizes, diameters, and have react with each other as well as with activities running at the demolition sites.

Figure.1: Dust at demolition site

Generally, airborne dust having different type particles which concentration in the atmosphere arise risk of dust at the location of sites as well as the developing area of the land. So, it is necessary to measure and to monitor at the demolition sites. As the result, the regulations and safety measures provide to avoid risk during activities existed at the various sites.

A. DUST:

- According to the International Standardization Organization (ISO 4225 - ISO, 1994), "It is characterized as little strong particles, traditionally taken as those particles underneath 75 μm in diameter, which settle out under their very own weight yet which may stay suspended for quite a while."
- According to the "Glossary of Atmospheric Chemistry Terms" (IUPAC, 1990), It is characterized as Small, dry, strong particles anticipated into the air by characteristic powers, for example, wind, volcanic ejection, and by mechanical or man-made procedures, for example, smashing, crushing, processing, boring, decimation, scooping, passing on, screening, stowing, and clearing.
- Dust particles are usually in the size range from about 1 to 100 μm in diameter, and they settle slowly under the influence of gravity.
- It is measured μg/m3.

B. TYPES OF DUST:

There are various types of dust suspended in the air which are given below:

Nuisance Dust:

Nuisance dust describes dust particles ranging in size from 1mm to 50μm, which reduce environmental amenity without necessarily resulting in material environmental harm. This form of dust generally originates from mining processes (among others) and is often the form of dust that affects neighbouring land users.

Fugitive Dust:

It refers to dust derived from a mixture of sources or a source not easily defined and includes dust generated from vehicular traffic on unpaved roads, materials transport and handling and un-vegetated soils and surfaces. Mine dust is commonly derived from such non-point sources.

DRI Dust:

It is very reactive, particularly with moisture, is exothermic and produces hydrogen gas (EPA, 2002). Stabilisation of DRI via hot briquetting or via passivation can reduce the reactivity, however, DRI dust can pose a hazard in process areas and during materials handling. DRI dust will not be generated during the construction phase of the project.

Type Description

Mineral dust Free crystalline silica (e.g., as quartz), coal and cement dusts

Metallic dust Lead, cadmium, nickel, and beryllium dusts

Chemical dust Many bulk chemicals and pesticides

Organic dust Flour, wood, cotton and tea dusts, pollens

Biohazard dust Viable particles, moulds and spores

According to living system of the residents and their various kind of the activities, there are various type of dust identified in the building which we will demolished. They are tabulated below:

Table.1: General form of dust available in building

Type	Description
Mineral dust	Free crystalline silica (e.g., as quartz), coal and cement dusts
Metallic dust	Lead, cadmium, nickel, and beryllium dusts
Chemical dust	Many bulk chemicals and pesticides
Organic dust	Flour, wood, cotton and tea dusts, pollens
Biohazard dust	Viable particles, moulds and spores

C. PARTICLE SIZE OF DUST:

Particles are generally classified by size as comparable streamlined diameters (EAD) in miniaturized scale meters (µm) as pursues:

- Total suspended particles (TSP) – diameter ≤ 50µm
- PM10 – diameter ≤ 10µm
- PM2.5 – diameter ≤ 2.5µm

Total suspended particulate:

Total suspended particulate (TSP) refers to particles that are suspended in air at the time of sampling. The equipment for TSP measurements is intended to collect all particles, from less than 0.1mm up to about 50µm, although different sampling heads can be used to select specific size fractions.

PM10:

PM10 is defined as the Criteria for air contamination comprising of little particles with a streamlined distance across not exactly or equivalent to an ostensible 10 microns (around 1/7 the breadth of a solitary human hair). Their little size enables them to advance toward the air sacs profound inside the lungs where they might be stored and result in antagonistic wellbeing impacts. PM10 also causes reduced visibility.

PM2.5:

PM2.5 Includes tiny particles with an aerodynamic diameter less than or equal to a nominal 2.5 microns. This fraction of particulate matter penetrates most deeply into the lungs.

Some of the most common hazardous substances in demolition work include:

Lead:

Lead is the most dangerous substance at the demolition sites which creates negative impact on air quality of locality when it is present in the air in form of fume or dust. It arises due to the activities like cutting steelwork coated with lead-based paint and due to process of dismantling the structural members of building.

Asbestos:

Asbestos is another hazardous substance which affects the air quality at the located sites. So that, where possible it should be removed before any demolition work starts and must always be removed by a licensed contractor. Generally, Asbestos may be found in sprayed coatings, thermal and acoustic insulation materials, fire resistant walls/partitions, asbestos cement sheets or flooring materials in the buildings.

Silica:

The dust particles of silica are more effective and concentrative with other particles available in the air. It occurs in stone, some bricks and concrete aggregate. Any demolition of structures constructed from these materials will give arise to dust containing silica.

Pollutant	TSP	PM10	PM2.5	So2	No2
Unit	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Low	<175	<50	<25	<245	<140
Moderate	175-500	50-75	25-30	245-350	140-200
High	>500	>75	>30	>350	>200

D. DUST GENERATION:

Dust is released when process involves free falling or handling of such materials, e.g., transferring, dumping, filling (bagging) or emptying bags or other containers, dropping material from a hopper to a weighing station, weighing, mixing, conveying and so on.

Dust generation activities:

- Vehicular movement
- Blasting activity
- Site clearance
- Segregation of debris
- Handling of debris
- Free falling activity
- Mobile crushing activity

E. EFFECT OF DUST AT DEMOLITION SITES:

During Demolition of Structures, considerable amount of Dust will be generated which will thus affect the activities carrying on the demolition site. As a result,

there are number of unfavourable effects occurring as enlisted below:

- Light scattering
- Glazing effect
- Fire bursting
- Chemical concentration
- Human health

F. LIMITING RANGE OF DUST SUPPRESSION:

According to SANS: 1926:2011: Ambient air quality limits for common pollutants (South Africa) provisions and monitoring data of the dust at the demolition sites are as shown below:

Pollutant	TSP	PM_{10}	$PM_{2.5}$	So_2	No_2
Unit	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Low	<175	<50	<25	<245	<140
Moderate	175-500	50-75	25-30	245-350	140-200
High	>500	>75	>30	>350	>200

Table.1: Limiting range of Air pollutant

G. RISK MONITORING OF DUST IMPACT:

Health effects caused by demolition should be necessary to determine the risk categories in reference to low, medium, high, or negligible. The demolition sites are assigned to a risk category based on two major factors.

- The scale and the idea of work, which decides the potential dust emission magnitude as small, medium and large.
- The sensitivity of the area with dust impacts, these are defined as low, medium or high sensitivity area.

Every site is different in terms of timing (seasonal), building type (construction material), duration of work, and scale of buildings (area, volume and height), therefore, professional judgment must be required for dust assessment at the location.

H. SITE EVALUATION:

The need and ability of a developer to deploy effective control measures is often dependent on the size and scale of the development. There are three major criteria to assess the potential impact of demolition site:

- The area taken up by the development.
- The number of properties being developed.
- The potential impact of the development on sensitive receptors close to development.

Site evaluation guidelines:

Low risk sites:

Development of up to 1000m^2 of land. Development of one property and up to a maximum of 10. Potential for emissions and dust to have an infrequent impact on sensitive receptors.

Medium risk sites:

Development of between 1000 to 1500m^2 of land. Development of between 10 to 150 properties. Potential for emissions and dust to have an intermittent impact on sensitive receptors.

High risk sites:

Development over 1500m^2 of land.

Development over 150 properties. Potential for emissions and dust to have a significant impact on sensitive receptors.

The dust emission magnitude combined with the sensitivity of area to identify the risk of effect with applied mitigation. Whether category is negligible no mitigation measures beyond those required legislation will be required.

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Table.2: Risk level of dust emission

I.DUST LEVEL MEASUREMENT:

The Microdust Pro is the instrument used to monitor particulate concentration such as dust, fume, smoke which are emit from any construction activity vehicle engine, manufacturing process etc. These pollutants reduce visibility and cause contamination of air due to which productivity of workers decrease. Some of these pollutants are toxic in nature these pollutants cause asthmas, bronchitis and lung cancer and also other disease.

Measurement by this instrument does not required and sampling period like traditional method. It is the real-time monitoring method. It is the ideal instrument to

measure real-time concentration of particle in mg/M3. It is the portable instrument having detachable probe. This instrument allows used to download the reading or data to the Casella the insight data management software. This instrument also provides real-time particulate concentration level measured by it thorough this application.

Operating procedure of microdust pro:

1. Providing power to the instrument with the help of batteries
2. Then fit the measurement problem
3. Then press the ON/OFF key to switch on the micro dust problem instrument after the switch on the instrument it shows an introduction screen for short period
    - First all the set up the language by selecting the earth icon
    - Then set the time and date by selection clock icon
    - Then set up display back light by selecting bulb icon
    - Alarm camera also set up by selecting bell icon, if you want to set it. then check the instrument zero and span. The Micro-dust instrument is very sensitive instrument so it is necessary to know that instrument is zero and span. this instrument is supplied with an optical 'calibration insert' which is used to establish a known instrument sensitivity or span. we can set the zero by selecting calibration icon.
    - Then insert the span calibration and calibrate the instrument.
4. Then start the measurement
   First of all, the open probe collar fully to expose the measuring chamber then move the probe from left to right to get reading.
5. There are two types of measurement; one maximum and other is average

- Maximum value: - This represent the maximum particulate concentration that occurred in any second period from the instant the measurement was started
- Average: The average value represents the average particulate concentration from the instant the measurement was start

6. We can have stored the data and also show if after measurement by selecting the folder icon
7. We can send this data to the computer by connecting the instrument to the computer through UCB cable.

HOW TO MEASURE DUST?

Dust can be measured by the “hand-held monitors” techniques which can be used to monitor the air quality, to know about the various negative and hazardous impacts, which will generate the risk of dust in the atmosphere of the amenity. The dust measured in the unit ($\mu g/m^3$).

The instrument set up at the taken distance one by one with help of hand-held monitoring techniques in inspection of the person who should take the data at that time. According to describe dust measurement sheet in chapter data collection sheet as below, Dust can be measure within the periphery in each direction North, south, east and west. Similarly, to measure the dust impacts on the site, the data collect in particular intervals of the distance as 10m, 20m, 30m, from the outer side of the building which is going to be demolish at the location of the site. Each data collects in the interval of hourly duration in each direction i.e., N, S, E and W, to ensure the risk of dust on the site. After collecting all the measurement data of the dust emission with help of the selecting instrument, the analyze of each collecting data take place for better understanding of effect of dust and adopt the provisions and mitigation as per conditions.

SAFETY PROVISIONS AGAINST DUST EMISSION:

Burning of materials on site shall not be permitted. Emphasis should be placed on using methods that do not cause unnecessary emissions (e.g. dust smoke).

Dust pollution will be minimized during demolition by the complete screening, if practicable, of the building or structure to be demolished with debris screens or sheets. A dust suppression system should be operated where necessary to minimize dust transfer into neighbouring premises. Wheel wash facilities should be provided on larger sites. Contact the local authority for their requirements.

The contractor shall ensure that the area around the site, including the public highway, is regularly and adequately swept to prevent any accumulation of dust and dirt. Where possible, skips and removal vehicles

shall be properly sheeted when leaving the site. Watering of rubble chutes shall be undertaken where necessary to prevent dust emissions. The contractor should take all necessary precautions to prevent smoke emissions or fumes from plant or stored fuel oils. In particular, measures should be taken to ensure that all plant is well maintained and not left running for long periods when not in use.

J. INTRODUCTION OF VIBRATION:

VIBRATION:

A periodic motion of the particle of an elastic body or medium in alternately opposite direction from the position of equilibrium when that equilibrium has been disturbed. "Vibration" describes the physical energy from a vibrating object, and also what we feel when that energy is transmitted to us.

PARAMETERS OF VIBRATION:

Parameters	Description
Frequency	• It is the number of cycles that occur during a defined time period. • Frequency is measured in "cycles per second" or hertz (Hz).
Amplitude	• It is the intensity or magnitude of vibration. • It is measured as the maximum distance an object moves from a central point. • Amplitude is measured in meters (m).

TYPES OF VIBRATION:

Transient Vibration

It is defined as a temporarily sustained vibration of a mechanical system. It occurs due to

- Blasting
- Impact pile driving
- Pavement braking

Steady-State Vibration

Vibration in which the velocity of each particle in the system is a continuous periodic quantity. It occurs due to

- Hydraulic breaker
- Heavy equipment's
- Mass excavation and grading process

SOURCES OF VIBRATION:

During the process of the demolition activities at the location of site, various sources are available to generate the vibration in different level which results in identifying the risk level at site. The various sources and activities are described below which generates vibration at various level.

- General demolition activities, such as breaking concrete, excavators grubbing up foundations.
- Heavy loader equipment avail at the site which act to break structural members with Impact forces.
- Due to material being dropped from height in order for materials to be removed from site at ground level.
- Use of Concrete crusher, it is likely to produce high vibration.
- Movements of General site equipment's, these encompasses heavy machinery operating over the site to demolish buildings and trucks removing debris from site.

K. IMPACT OF VIBRATION ON STRUCTURE:

Short-term Vibration:

Vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated. i.e; demolition activities.

Long-term Vibration:

All other types of vibration not covered by the definition of short-term vibration. i.e; industrial activities.

In demolition activities generally, the structure will be affected by the short terms vibration.

Impact of vibration on adjoining structure:

- Due to working condition of dismantling the members of the structure, vibration arise from the activity and affect the stability of the surrounding structures.
- As per selection of various demolition techniques. Different levels of vibration will be generated and thus it will affect the structure and reduce the bearing capacity of floor.
- As the vibration level increases more than its risk limit, cracks will arise in plastered surface at wall of the building.
- In poor structural condition the partition wall will become detached from the joints due to higher vibration.

- The hazardous level of vibration will lead to the secondary damage like, leakage and corrosive effect in the structure.

For commercial and industrial building at the frequency of vibration is between 1 to 10 Hz. The vibration should not exceed above 20 mm/s and the frequency is between 10 to 50 Hz, the variation should not exceed above 20 to 40 mm/s. similarly at highest floor, vibration should not exceed above 40 mm/s

IMPACT OF VIBRATION ON GROUND:

1. Ground transmission vibration:

- Ground vibrations is a technical term that is being used to describe mostly man-made vibrations of the ground.
- The ground vibration is literally a wave motion, spreading outward from the blast like ripples spreading outwards due to impact of a stone dropped into a pond of water. As the vibration passes through the surface structures, it induces vibrations in those structures also.
- These vibrations induce a resonance in the structures if the frequency of ground vibration matches with the frequency of the structure and due to this, amplitude of the vibration may exceed the amplitude of the initial ground vibrations.
- Frequency and peak particle velocity (PPV) are most commonly used parameters for assessment of ground vibrations.
- Geological discontinuity also plays a very imperative role in the transmission of ground vibration.
- The distance from blast face to vibration monitoring point is one of the most influencing parameters. If distance is more, then vibration will be less due to dissipation and dispersion of waves.

HAND-ARM VIBRATION EXPOSURE:

Hand-arm vibration is the most common form of segmental vibration experienced in work settings. Hand-arm vibration occurs when a person holds or guides a vibrating tool or machine with their hand or hands, and vibration is transmitted from the tool to the hand(s) and along the arm(s).

A person's exposure to hand-arm vibration and the health impacts of exposure can be influenced by many factors, such as:

- The temperature of the area the person is working in
- Whether or not the person is wearing gloves
- How the tool is gripped?
- The frequency and amplitude of the vibration
- How long and how often exposure occurs

HEALTH RISKS, SIGN AND SYMPTOMS:

Workers exposed regularly to excessive hand-arm transmitted vibration may be suffering in the long term with disturbances to finger blood flow and to the neurological and locomotor functions of the hand and arm. The term hand-arm vibration syndrome is used to refer to these complex disorders.

WHOLE BODY VIBRATION EXPOSURE:

Whole body vibration occurs when a person stands or sits on a vibrating vehicle, machine or surface.

The vibration is transmitted through supporting surfaces such as the standing person's feet, the buttocks of a seated person, and the supporting areas of a reclining person. Whole body vibration exposure often comes from a variety of different vibration sources from one or more components of a machine, vehicle or surface.

These sources can include:

- Engines and engine parts
- Movement of gears and transmissions
- Rotation of tires, wheels and axles
- Movement of the vehicle over irregular surfaces

III. CONCLUSION

At the location of the demolition sites, the impact of dust and vibration is more critical and due to duration of the work of the demolition of structures, various negative impacts about dust emission and vibration exposure are found out.

To provide the provisions and the mitigation about the impacts of dust and vibration along the demolition work to the surround activities as well as human health in actual condition, the limitation values are identified. To know about more details about safety provisions as well as exposure about dust and vibration effects on sites, the data collections sheets were generated.

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