Environmental Impact & Mitigation Measures during the Construction of Underground Station and Tunneling at Mumbai Metro Line-03

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Abstract

During the construction of underground station & tunnel, there are various environmental aspects are taking into consideration from designers, workers, and management departments. Identify various environmental Impact during excavation, drilling, tunnel mining for TBM machine, shotcreting, JCB machine, etc. which creates lots of air and noise pollution in environment & human being life affected, also others parameters cause the affected environment and disturbing human life - like water pollution, hazardous waste, E-waste, chemical waste, bio-medical waste, food waste, MS scrap generated, hazardous gasses releases due to mining work at tunnel / NATM work at site level and for controlling all those things taken mitigation measures on it. During the construction phase, both positive and negative impacts are taking into consideration to have an idea about resultant impacts. These impacts are classified into different period of the project repetition namely, location, design construction and operation. Ambient air quality and noise levels were monitored and around the project area to develop present baseline levels in the area. The existing level of pollution in developing cities parameters like suspended particulate matter (SPM), CO2, CO, SOx, NOx, etc. is on higher side or above the acceptable level which causes adverse effect on health of the city.

Keywords: *Environmental Impact, Mitigation Measures, Underground Metro and Air Quality*

1. Introduction

The suggested underground metro line-03 project is also known as the aqua line or the Colaba–Bandra-SEEPZ line, which is 33.5 km long length of the underground metro. The estimated project cost is ₹30,000 crore (US$4.2 billion) Increasing population pressure on Developing countries creates negative environmental impact and pushing pollution to a high level [1]. To mitigate the problems of city people's infrastructure projects are constructed on large scale such as the underground metro to minimize city free from the problem of traffic pollution, waste generation, water problems[3].

Constructed for efficient transport strongly relies on road and railway tunnel, both in Long-distance Traffic and in metropolitan areas. However, when the construction of an underground metro started there is a serious impact that arises in metropolitan areas. Geologically, Mumbai presently shows a large amount of diversity in nature. In and around Mumbai locations major rocks are fine-grained, greenish basalt to black colored, asphalt rock. Compact basalt and weathered amygdaloidal Basalt are also found as characteristic of the Deccan trap. They are associated with acidic and basic tuffs, volcanic breccia with fallacious matrix, Trachyte and also occasionally, rhyolites. Inter trappean beds representing breaks in the tectonic volcanic activities are seen in the western ridges. The westerly hill ranges like Malabar, Cumballa, Tardeo and Worli consist of compact Basalt rock on the surface [3].

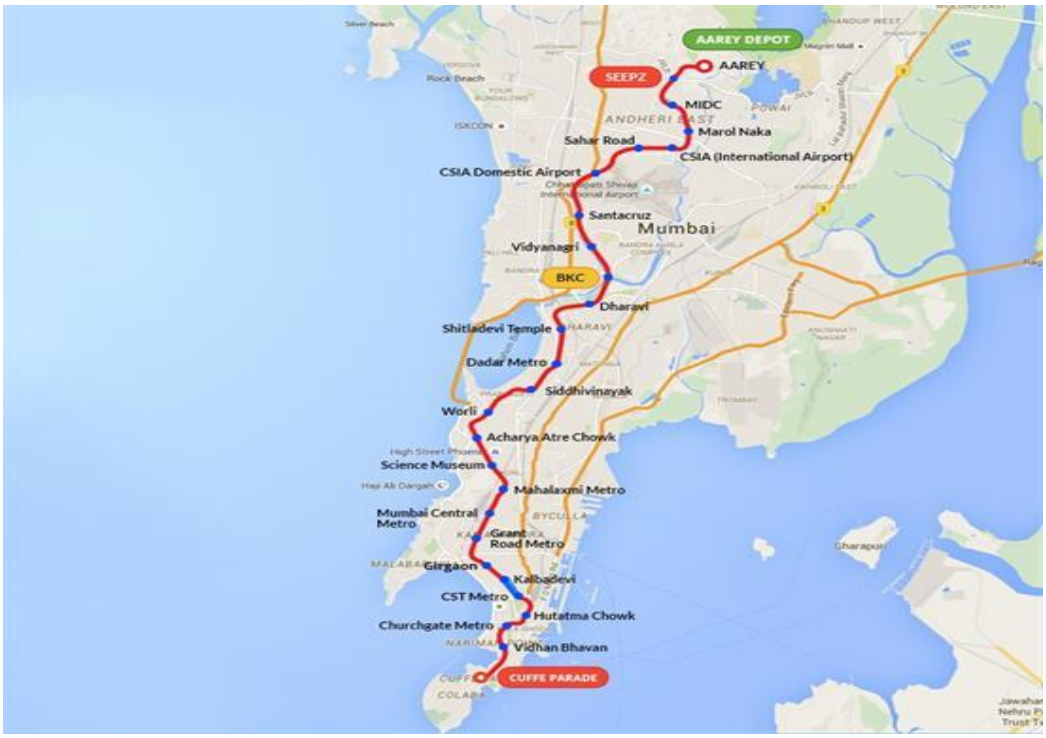

Figure 1. Proposed Colaba to SEEPZ Underground Metro Line-03 Project

2. Methodology

2.1 Impact of Noise on Environment and Human

During the construction of the underground metro there is a lot of various activities are going on such as construction, demolition, transportation, etc., which creates high amount of noise generation [3-5]. The construction activities which are expected to cause lots amount of noise generations like mining, excavation, rock breaking, blasting, piling, muck disposal by dumpers, drilling, core cutting, grouting, shotcrete, concreting, segment casting, etc. (Tunnel Boring Machine), J.C.B. machine, hydra, various types of cranes, excavators, breakers, rig machine, drilling machine, shotcrete machine, heavy vehicle movement, etc. The harmful impact of noise pollution during construction sites is hearing problems, health issues and sleeping disorders. Noise impact on the human body during construction sites which are generally classified into two types are acute hearing loss and chronic hearing loss. Acute hearing loss during the heavy construction phase is also known as “sudden deafness”. It occurs mainly when any person loses hearing very quickly [5-6]. Symptoms of sudden deafness are muffled conversation sounds, Inability to hear when there is a lot of background sound, dizziness, and difficulty of hearing

high pitch sound, mental stress, and habit of talking loudly. Chronic hearing loss is also known as "permanent hearing loss" it is mainly observed during the construction phase when workmen work in a high level of sound pressure for long term exposure, which may result in decreasing work efficiency, irritability and nervousness [5].

Figure 2. High Amount of Noise Generation during Use of Heavy Vehicle in the Underground Tunnel Construction

2.2 Mitigation Measures for Noise Impact: To prevent an increase in noise level maintenance of equipment and noise level monitoring is carried out on a regular foundation [3]. If noise level exceeds during construction work, then strictly mitigation measures followed at a site such as providing earplugs to workmen, most of the times using electric equipment instead of diesel-powered equipment, using hydraulic tools instead of pneumatic tools, Acoustic enclosures are provided for individual noise - generating construction equipment, Scheduling of truck loading to minimizes sound level. Using low - speed compressor and blower, during heavy construction work providing a frequent break to workers, Minimizes hammering and dropping work at night, conducting daily tool-box talk (workmen) meeting to remind and educate the workers regarding noise control measures [3-6].

Figure 3. Noise Barriers around the Compressor of King Post DTH Machine

Environmental awareness training is also conducted which includes the importance of Personal Protective Equipment (P.P.E.) like earmuff or earplug,

safety jacket, nose mask and eye goggles while operating heavy vehicles and instruments during the underground tunnel construction phase. According to the Central Pollution Control Board (CPCB), every factory should adopt suitable engineering control or administrative measures shall be taken [5]. No workman is exposed to sound levels exceeding maximum permissible noise exposure levels which is mainly specified in the below table [5-6]. (As per Schedule XXIV of Model Rules under Factory act 1948)

Table 1. Permissible Exposure in Cases of Continuous Noise

Total Time of Exposure (Continuous or Short Time of Exposure) Per Day, in Hours	Sound Pressure Level in dB (A)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.75	107
0.5	110

2.3 Impact of Fugitive Dust on Environment & Human Health

There is various air pollutants are generated from construction activities such as particulate matter (PM10 and PM2.5), Nitrogen dioxide (NO2), Sulphur dioxide (SO2), Carbon Monoxide (CO), During construction in tunnel cotton water curtain is used to minimize dust after sprinkling is also done at the construction work site on a regular interval basis [3]. For maintaining ambient air quality at construction site High Volume Sampler is installed continuously 24 hours to determine 24 hours average concentration. This air sampling performed at a height of 3.0 m (approximately) from ground level. Environmental monitoring of ambient air quality has to be carried out daily three times for measuring impacts of project activities on the surrounding area. The basic aim of the air quality monitoring is to preserve and improve the quality of air. Ambient air quality is monitored as per “National ambient air quality standards" notification G.S.R.176 [6].

Air Pollution Control Measures during Drilling and Blasting: During drilling work in cross passage (CP) area there is a lot of dust generation which contains a lot of small particulate matter like PM10, PM2.5, SO2, NO2, CO, HC which creates toxicity in nature. To minimize this toxic pollutants cotton water curtain is installed. Over certain period, water is sprinkled over a cotton water curtain to remove all suspended particulate matter. During drilling and blasting work mandatory providing nose mask and earmuff [9].

Figure 4. Water Curtain Used during Construction to Minimize Air Pollution

Figure 5. Hazardous Gas Detector at Different Construction Site

2.4. Impact of Hazardous Waste on Environment and Human

During the construction of tunnel and station, there is a huge amount of waste generation which will directly impact on environment & human [4]. Waste is generally classified into four group's general waste, chemical waste, construction waste, hazardous waste. General refuse pollutants are paper and food waste generation which is near labor colony, site office, stores and also at batching plant areas , Construction waste is generated through various construction activities most of them are harmful to human body & environments like grouting mixtures, surplus concrete, sand , rock and brick. In general, refuse and construction waste recyclable or reuse is possible in a greater amount. Adoption of recycling, reuse and reduce techniques during construction waste management. Various types of waste that can be recycled and reused at the construction site such as concrete recycle for use of aggregate in new concrete, topsoil recycle for landscaping, plastic recycles for consultation with the supplier. Separate dust bins with color coding are done for the collection of refuse waste material at the construction site. Refuse waste material should not mix with other waste like chemical and hazardous waste material. Removal of refuse waste material is done daily to avoid bad odor, pest and litter impacts on the surrounding environment. Authorized waste collectors (Municipal Corporation) are deployed for collection and systematic disposal of refuge waste material at the construction site. According to CPCB standards, there are separate dust bins types with color coding are followed at the construction site [5].

Figure 6. Separate Color Coding Dustbin Provided at Construction Site

Table 2. Color Code of Dustbins

Waste Type	Color Code
Biodegradable	Green
Recyclable	Blue
Combustible	Red
Biomedical	Yellow

2.5. Impact of Water on Environment and Human

Water is the most essential resource during construction activity, but it is a scarce resource in our country. During construction time the source of water is coming from multiple sources hence, impacts are different [8]. For construction purposes, the source of water is mainly from a bore well and tanker supply. For drinking purposes, freshwater is supplied through tankers and Reverse Osmosis (RO) system is also installed. Discharge of untreated or partially treated wastewater creates a major impact on human, trees and water bodies which mainly includes sediment pollution (siltation) in drainage pipes which may block pipes and increases flooding risks, Increasing level of turbidity in receiving water creates a negative impact on the ecosystem, Oil grease and other hazardous chemicals soak into the ground which contaminates ground and drinking water, causes water - borne diseases, as well as paint and toxic material, add to water can harm and kill aquatic animals and changes taste of water. During the construction of the underground metro, wastewater contains various heavy metals like lead, arsenic, cadmium and mercury which creates a negative impact on the human body system [8-12].

2.5.1. Mitigation Measures for Water Pollution Generated at Site

Figure 7. ETP is Installed for Treating Waste Water

Effluent treatment plant (ETP) is mainly installed during underground metro construction to remove the unwanted, hazardous chemicals from the wastewater to meets the statutory water pollution control requirements. The volume of the Effluent Treatment Plant (ETP) is 30MLD [3].

2.6. Muck Waste Management

Muck is dirt, rubbish, or waste matter hence, disposal of muck is the necessary deposition of dropped or spilled muck upon public roadways and paved streets causing dust pollution , Due to his there is mitigation measures are strictly applicable to all construction site such as the muck generated and disposal record Monitoring result is maintained at all construction sites, overloading of muck carrying heavy vehicles are strictly avoided, wash the wheels of the truck vehicle by using the force of water, all the muck carrying vehicles are covered with tarpaulin covers and adequate precautions are taken to avoid air pollution, muck is disposed of during night-time to minimize air pollution [1-3].

Figure .8 Daily Washing of Truck Wheel Wash Tracker to Remove Muck Generated During Construction Work.

3. Observation and Result

3.1. Air Monitoring Result

During underground metro construction activities, there is a lot of dust generated, hence monthly Air monitoring is done compulsory during construction activity to minimize air pollution and adopting proper mitigation measures [10]. Air monitoring is mainly done by a High volume sampler (HVS) instrument. During air monitoring at the different construction site with help of High volume sampler (HVS) instrument, there are various air pollutant parameters are taking into consideration to minimizes and monitoring air pollution at construction site parameters such as Particulate (PM10 & PM2.5), Nitrogen dioxide (NO2), Sulphur dioxide (SO2), Carbon Monoxide (CO) & Hydrocarbons (HC) [11].

Table 3. Ambient Air Quality Monitoring Result at Construction Site

Specific Matters and Gases	Quantity	Time	C.P.C.B Permissible Limit	Construction Site					
				CY	MIDC	MN	PG	SZ	RM
PM_{10}	$\mu g/m^3$	24 hrs.	100	92.3	91.0	87.8	90.1	89.9	92.3
$PM_{2.5}$	$\mu g/m^3$	24 hrs	60	55.3	54.5	37.9	50.1	53.5	56.5
SO_2	$\mu g/m^3$	24 hrs	80	39.7	45.6	56.5	39.7	35.4	37.8
NO_2	$\mu g/m^3$	24 hrs	80	45.8	50.3	52.3	60.3	70.1	60.7
CO	$\mu g/m^3$	24 hrs	04	1.1	0.9	0.3	0.89	2.1	1.3
HC	$\mu g/m^3$	24 hrs	05	0.6	0.78	0.9	1.13	0.98	0.68

Different construction sites name in above table:

Note: CY-Casting Yard, MIDC- Maharashtra Industrial Development Corporation, MN-Marol Naka, PG-Pali Ground, SZ-SEEPZ, RM-Ramp

Discussion: From the above table, it is concluded that there are monthly monitoring differences between permissible value and measured value at the different construction sites. It is observed that air quality measured value at the different construction sites is lesser than the CPCB permissible limit [3]. Air pollution is higher on the Pali Ground construction site hence, mitigation measures during construction time are strictly employed.

3.2. Noise Monitoring Result

During underground tunnel and station construction work effects of noise generation is more because of confined space (It is space with limited entry or space in which only one path for entry and exit condition.) increases the echo of sound [4-10]. Hence, at construction work, noise level meter is used for monitoring & proper mitigation measures are implemented. Noise monitoring is done three times per day during heavy construction work. To control this unwanted sound during the underground construction of tunnel proper mitigation measures are implemented such as providing earmuff, earplug to workmen during operating heavy machines in the underground construction of the tunnel. Proper maintenance and silencing heavy machines like bobcat machine, drilling machine and rock splitter machine , etc. minimize noise emission at a particular source. With the help of the baseline situation of that site, actual noise monitoring and C.P.C.B noise permissible limit data graphical representation of noise monitoring are done monthly [6]. At construction site noise monitoring is done twice in a week at every location. At day time of noise, monitoring is from 6:00 a.m. to 10:00 p.m. night time monitoring from 10:00 p.m. to 6:00 a.m. The average noise level at all construction sites is carried out every month to better understanding the maximum average noise level at the construction site.

Table 4. Average of Noise Monitoring Level at Different Construction Sites

Site location	Average noise level at day time dB (A)	Average noise level at night Time dB (A)
MIDC station	67.7	65.2
Marol Naka	55.8	66.5
Seepz Station	70.3	64..6
Casting yard	66.9	64.4

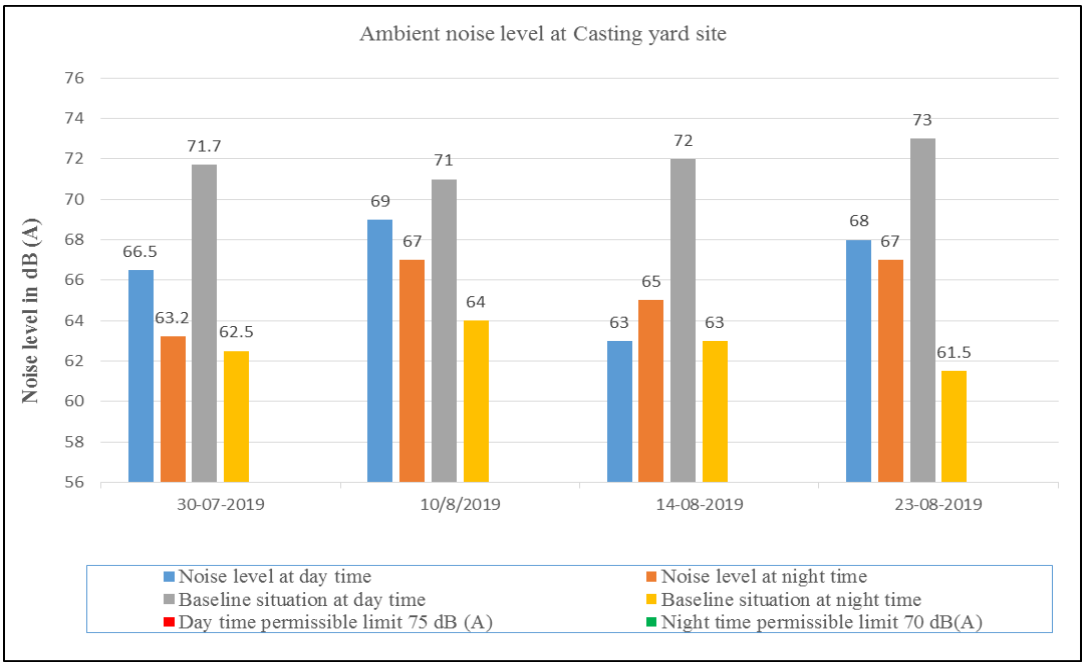

Figure 9. Monthly Ambient Noise Monitoring Result

Discussion: From the above graphical representation, it is concluded that in the day time there is a lot of noise pollution generated. Hence, it is very necessary to take proper mitigation measure during construction at day time. In the above table, there is a comparison between the permissible limit of CPCB and measured value by the sound level meter in which day time is also high noise level is obtained.

4. Conclusion

The underground metro construction has been proved that it is more efficient in terms of energy consumption, the fastest and cleanest mode of transportation and without disturbance of traffic. The “Mumbai Metro Line-03” gives benefits to the economy, traffic congestion reduction, quick and safety transport, employment opportunities, fuel consumption reduction, air & sound quality improvement [1-3]. During heavy construction of tunnel and station work, there is a need for daily environmental monitoring and maintenance records like gas monitoring, lux monitoring, noise level meter, temperature and wind monitoring to minimize and taking proper mitigation measures to reduce and remove health hazards during heavy construction work.

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