Construction and Management of Advanced Underground Transportation System

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Abstract
Underground Transportation deals with the construction and management of an underground network facilitating movement from one place to another with development of all the infrastructure development needed to aid this network.
Keywords

Deep Excavation, Construction Methodologies, Tunnelling, Kolkata Metro Project.

Introduction
In building the infrastructure for transportation, that is, railways or highways in any country of the world, the built-up areas, waterways, dense forests, mountains, etc. are avoided as far as possible unless the same are needed for a right and economically viable alignment. When the alignment reaches a city, the considerations for acquisition of land are different. The city traffic planners should keep in mind the environmental and the social aspects while planning the development of the transportation infrastructure.
While considering social aspects, it has to be kept in mind that there is a worldwide trend, particularly in developing countries, of continuous migration of people from rural areas to cities in search of better livelihood and urban facilities like education, health and other services which are not available to them in rural areas. There is a growing aspiration for better lifestyle due to the present economic growth resulting from globalisation. So urbanisation becomes imperative for the present society. India has a vast population of more than 1.2 billion. It has the potential to build up its own infrastructure for urbanisation for the benefit of both urban and rural people. Besides housing, water supply, power and telecommunication etc., transportation network plays a vital role in the infrastructural development for urbanisation. Unless this is done, the very purpose of urbanisation is defeated.
In the present global scenario, climate change in different parts of the world due to emission of greenhouse gases into the atmosphere is a concern of climatologists and environmentalists. So the engineering infrastructure, which is required to be developed, for transportation either

by overground or underground construction should be environment-friendly. The environment of the neighbourhood should not be polluted by any construction activity. The city authorities, in the face of congestion of surface traffic are in recent times advocating for environment-friendly underground / elevated traffic in place of extending or modernising the congested surface traffic. The real estate developers of cities are interested in vertical expansion rather than horizontal expansion due to sky-high price of land. Construction of high-rise buildings with multi-storied basements for car parking has become necessary to accommodate the urban migrants. So, necessity of underground infrastructure either in the real estate sector or transport sector cannot be ignored in the present scenario. Accordingly, importance of underground construction management would increase manifold in the coming years. It needs to be mentioned that underground construction management plays a vital role in geotechnical engineering. So, if a geotechnical engineer is posted as a site engineer of an underground project, he would do a better job as compared to any other engineer.

Characteristics of Deep Excavations

The sky-high cost of land in cities has restricted the scope of horizontal expansion of space in cities. The need of urbanisation has forced civil engineers to go in for vertical expansion. Deep excavations are being needed in large cities to create space for housing, parking lots and other purposes. The retained soil support or the retaining wall in the case of deep excavation may be made of steel piles, contiguous bored piles or reinforced concrete diaphragm walls depending on the depth of excavation, type of soil, groundwater profile and the type of structure to be built. The tackling of deep excavation is different for different type of structures which are constructed underground. For example, the characteristics of a deep excavation while building multi-storied basement of a tall building in a specific location of a city is not the same as the characteristics of a deep excavation when building an underground corridor below a traffic road.

While undertaking deep excavation work in order to build multi-storied basement of a tall building in a city, it is desirable to protect the excavation area by constructing retaining walls all around and to cover the area of construction by decking to reduce dust to the maximum extent. For building an underground corridor for road or rail below a road carrying heavy traffic in a city, the decking supported on the retaining walls on either side of the excavation prevents dust as well as holds the surface traffic during the ongoing progress of work along the corridor.

Underground excavations, whether for laying a sewer or water supply main, for construction of substructures of flyover / road-cum-rail over-bridge, for construction of multi-storied basement for car parking of a tall building or for construction of an underground corridor for rail or road, is classified as shallow or deep based on the depth of excavation. Shallow excavations, which are less than 6 metre in depth below the ground surface, may or may not require retained soil support depending upon the type of soil and its properties. For deep excavations, which are more than 6 metre deep below the ground level, retained soil support system is mandatory.

Possible construction hazards while carrying out deep excavation projects include, but are not limited to, caving of soil through the gaps of piling walls, honeycombing of concrete diaphragm walls resulting in seepage from outside the diaphragm wall inundating the excavated trench, leaking of underground wet utilities, settlement of buildings within the influence zone of deep cut and failure of the de-watering system.

Stability of Deep Excavation

Before carrying out any deep excavation the stability of the cut at any stage of construction needs to be checked against heaving of soil from below the excavation at that stage. If the load of earth supported by the retaining wall at the excavation level added with superimposed load at the top of the excavation does not exceed the bearing capacity below that level with a reasonable factor of safety, heaving and bursting the base of excavation is totally eliminated.

Before planning the infrastructure for transportation in an existing city, the proportion of road area to the total city area expressed as a percentage should be ascertained. If the road area is less than 25% of the city area, an exercise is to be done to determine as to whether the constraint can be removed by demolishing the structures and buildings on either side of the traffic roads. Sine this is usually impossible due to legal complications or political compulsions, then engineers may go in for overground and underground transportation in lieu of extending the congested surface traffic. Considering the city roadways to be the main feeders to the city railway stations, freight and passenger services, any underground construction undertaken along the main roads of a city are to be executed using environment-friendly technologies.

Before commencing any geotechnical engineering work, the geotechnical characteristics of the area of geotechnical working, including the hydrological characteristics, have to be studied in detail so as to ascertain the nature of ground profile and the position of the groundwater table. The characteristics and properties of the soil are required to be known from the laboratory analysis of the bore hole data to determine the strength, stability and deformation under the action of the external forces and the self-imposed load. The soil strata profile obtained from the series of bore holes is an indicator to select the foundation level of the transportation infrastructure to place the bottom of the substructure of underground construction needed in bridges, flyovers, tall buildings with basements or a corridor for rail or road. The soil strata drawing is necessary to fix the vertical alignment of a tunnel or an underground corridor after fixing grades. The groundwater table varies from city to city and from place to place. In some cities, the groundwater table reaches the ground level in the monsoon season. If the water table is higher than any stage of excavation level, the water table should be lowered well below the excavation level by de-watering through well point pumping system for onward excavation below that level. The de-watering technique is applicable up to the final level of excavation in cut-and-cover construction technology.

For geotechnical construction in a city, it is essential to collect from the concerned authorities, the underground maps showing the locations of embedded dry and wet utilities. If maps are not available the utilities are to be located by pre-trenching or by applying sensor indicators. After the alignment and depth of the utilities are ascertained, the engineering design personnel are to make arrangement to temporarily divert some of the utilities overground. The same utilities are required to be restored in their original location after completion of the permanent structure and restoration of the site by backfilling. The utilities which cannot be diverted overground are kept hung from the top strutting or supported on the bottom strutting of the braced excavation. Damage to telephone and electrical cables and leaking of wet pipelines is to be avoided. If these precautions are not taken at site, there are chances of disorder of communication and failure of electricity and water supply in the neighbourhood. If there is any leakage of sewer or water supply line, the excavated trench will be inundated very fast and construction activities will be stopped till the sewage or water is removed and cleaned

from the trench. The elimination of such undesirable incidents needs continuous monitoring of the excavated site.
The alignment for underground and elevated corridors has to be determined so as to have easy grades and curves for a comfortable ride. Straight routes are to be chosen as far as possible to reduce time of travel and cost of construction.

Determinants for an Ideal Traffic Network

Primary determinants
Adequate access for surface traffic (to the tune of twenty five percent).
Traffic roads and streets to be made of mastic or concrete for at least four lanes.
Multi-tier flyovers running over, crossing or bypassing the main roads.
Underground and / or overground corridors for rail or road.
Express ways for super-fast traffic.
Running of light rail traffic / modernised trams on elevated corridors.

Secondary Determinants
Rigid / flexible pavements for two-wheelers on either side.
Fewer junctions and crossings.
Slow-moving vehicles to be phased out in stages.
Terminating the heavy-duty vehicles on the outskirts of the city.
Synchronising the traffic signals to prevent piling of vehicles.
Putting an end to joy-walking by motivating the pedestrians to use footpaths.

Classification

Infrastructure may be classified use-wise, location-wise and durability-wise.
Use-Wise
Engineered structures are of different types, for example, dams, bridges, skyscrapers, roads, etc.
Location-Wise
Infrastructure development may be undertaken in metropolitan cities, non-metropolitan cities, towns, semi-urban areas or villages.
Durability-Wise
Extremely durable structures, for example, dams, bridges, underground railway tunnels, tall monuments, etc.
Structures having shorter design life, for example, residential buildings.

Mass Rapid Transport System (MRTS), which is an important infrastructure for urbanisation in the present global scenario, may be developed overground, underground or on the surface of the ground depending upon the topography, soil characteristics, the ruling gradient of the alignment, character of the location, availability of land, economic viability and some other issues, for example, finance, time, legalities and politics.
There are different construction methodologies for underground construction projects, out of which judicious choice of method is to be made considering the site, the condition of soil, the surrounding environment, the budget, the time factor, the need of the people, etc.
The cheapest and easiest method is by open-slope construction keeping the side walls at the natural angle of repose of the soil. This makes the inclined side walls self-supporting.

However, it has got severe limitations. It would not be wise to adopt this method for deeper excavations so as to avoid acquisition of larger area of land. The open-slope method is also not applicable for underground excavations in urban areas as it involves wider excavation, disposal of huge quantity of earth spoil and pollution of the surrounding environment by dust of the soil from the excavated spoil. The municipal authorities of a city or town normally use timber shorting for laying a shallow sewer line or a water supply main. For deep excavations of more than six to nine metre depth, the soil support system (retaining wall) should be made of steel sheet piles of smaller sections. For excavations between nine to twenty meters, interlocking steel sheet piles of heavier sections, steel/in-situ concrete bored piles at 0.5 to 1.0 metre centre to centre or reinforced concrete diaphragm walls should be used to serve as retaining walls. The excavated trench is required to be braced by strutting and waling made of steel sections which remain temporarily till the permanent structure is built. This is called the cut-and-cover construction because it involves cutting, excavation, construction and covering. In the cut-and-cover mode of construction, the excavated trench being open is prone to dust of soil in the process of grabbing the soil by the modern excavators. To eliminate such dust of soil, the width and length of the proposed excavated trench is covered by steel decoking prior to commencing excavation through the predetermined hole in the decking.

While undertaking excavation work for multi-storied basements of a tall building in a city, it is desirable to cover the area of construction by decking to prevent dust to maximum extent. For building underground roadways and railways below the road carrying the surface traffic in a city the steel decking should be made strong so as to carry the existing surface traffic during the ongoing process of underground works along the alignment. The construction method is then called cover-and-cut construction in lieu of cut-and-cover construction. Both the methods are conventional and cost effective for cities of developing nations except when the alignment crosses a waterway or a deep valley.

Another conventional method for constructing an underground corridor for rail or road is Shield Tunnelling. If the alignment crosses a river, the tunnel is driven below the bed of the river and the gradient of the alignment on either side of the river has to suit the gradient under the bed of the river. Where cut-and-cover construction is difficult, or rather impossible, there is no alternative other than to go in for tunnelling as is the case of crossing a deep waterway or a very deep valley. The advantage of tunnelling over cut-and-cover is that an underground corridor is constructed without removing the overlying soil or rock. Though the process of tunnelling in the city is costlier than cut-and-cover, it has other advantages. The quantity of materials required to be handled are significantly less in tunnelling compared to cut-and-cover. The other ancillary works as in cut-and-cover construction in cities that is diversion of traffic and the diversion of underground utilities are not necessary in the case of tunnelling. The tunnelling is a trenchless excavation piercing normally below the level of deepest sewer or water supply main. There is no dust of soil, and hence, pollution of air is less as there is no open excavation. Failure of underground utilities is eliminated as the utilities are generally above the tunnelling.

The shield tunnelling technology consists of a shield (rigid frame) which is lowered vertically through a pre-built shaft up to the desired level of proposed tunnelling. After lowering, the shield is made horizontal and pressed forward through soft ground by jacks, preventing the soft ground from collapsing. The shield is moved forward by jack to build the tunnel support structure in segments. It is apparent that the shape of the shield should be circular or rectangular for building a circular or rectangular tunnel.

Inspection of Structures

Buildings and structures lying within the influence zone of the proposed cut of excavation either in a fixed arena (for construction of multi-storied basements) or along a roadway in a city or town (for laying a pipe line or a corridor) are to be listed for detail inspection in regard to their age, condition, materials of construction, type of structure, visible cracks, inclination, settlement, etc. before the excavation is commenced. The depth of the proposed excavation up to final level is the criteria to determine the influence zone. The conditions of wet pipe lines surrounding all the affected buildings need a very careful inspection prior to start excavation. Any leakage in the concerned pipe lines is prone to erosion of soil below the foundation of the buildings. Once the excavation proceeds. This may result settlement to the buildings causing concern to both the developer and the engineering institution of the concerned project. The degree of settlement varies with the vertical rigidity of the retaining wall supporting the excavated cut and so with the amount of movement of soil behind the retaining wall. Any deep excavation over the soft silt-clayey strata is liable to some movement of the surrounding soil due to yield of the retaining wall. Excessive settlement caused by such yield to the old buildings lying within the influence zone may invite disaster. The landlords and the builders become jittery over such casualties which will delay the completion of the project. To prevent such happenings the engineer at site should maintain all records of his monitoring the cracks or fissures as observed in the concerned buildings. He should fix tell-tale over the cracks and monitor regularly. Any widening of cracks will dislocate the tell-tale and indicate the occurrence of settlement to the buildings. Once such incidents occur, the site engineer should take all precautionary measures such as sealing of leaks in the wet pipe lines, grouting the foundation of the buildings, supporting the cantilever and other vulnerable portions of the affected buildings by steel joists and beams as warranted at site. The very old buildings may be required to be made stable by underpinning if situation demands during the progress of work in the case of major repairs the occupants may be needed to be rehabilitated temporarily to nearby locations. In case the buildings within the zone of influence of the excavation are very old, dilapidated and beyond repair, it is better to demolish those buildings before the excavation started. Otherwise the same may invite disasters during the construction sequences.

Quality of Construction

Proper sieve analysis of fine and coarse aggregates transported from different queries are to be carried out before designing the correct mix of concrete required for underground construction projects. Correct water cement ratio for the concrete mix is needed to be controlled to obtain a dense concrete of high permeability without chances of corroding the reinforcement at a later state. This is necessary to make the finished product sound and durable. Besides, right steel, cement and aggregate should be used for the right concrete product depending of the type of use and utilisation. For a big underground project, a batching plant is a must. It should be located at a central point if construction of a corridor is taken up along a roadway which may be closed to traffic fully or partly by providing suitable diversions. Ready mix concrete are to be transported at any site by dumps fitted with revolving drums using suitable admixtures / retarders to delay the setting before pouring the mix. It is needless to mention that vibration followed by compaction should be of high standard to obtain pore-free and honey comb-free concrete product. Curing the finished concrete product for the permissible period is essential to achieve the desired strength. Despite all precautionary measures are taken to pour the concrete by chute from the top in the vertical concrete retaining walls supporting the deep excavation, the appearance of honeycombing in any layer cannot be escaped. If such honeycombing is discovered after excavation below that layer, attempt to be made to grout those immediately to prevent seepage of ground water inside the trench.

Leadership and Management

The engineer at site should be basically more a professional manager than an engineer with the excellence in preserving knowledge, communication skills and decision making. The engineering manager is supposed to have an in depth knowledge in his own field with some knowledge in other disciplines those are needed in underground construction industries. The essence of communication skill which an engineer at site should have, involves the sharing of facts, feelings, ideas, information and attitudes of the total manpower engaged or involved at site. Besides careful implementation of ideas, sticking to deadlines etc. the site engineer is desired to have all information of resourceful outsourcing needed for high tech globally competitive projects. The engineer at site of good managerial aptitude, adequate technical knowledge, and courage to face any unforeseen situation and to act as a lead engineer to guide the construction team is the right person to be entrusted in the underground construction project. The employment of unskilled labours and the artisans should be discouraged in the underground projects. To create employment potential, proper training could be provided by the authorities to the unskilled labours, artisans and the other construction workers to become fit to work in the underground sectors. This will create awareness among the works to build a conducive atmosphere with least chances of unforeseen happenings and protecting the environment in the arena of working.

Casualties, Disasters and Mitigation

Though complete avoiding of casualties and disasters cannot be guaranteed, a detailed comprehensive planning, management and determination can reduce the damage to the minimum extent. It requires no mention that such a strategy would help the project authorities to control the anticipated cost without incurring any unforeseen expenditure. Such strategies would not only control the budget but minimise the chaos in the neighbourhood and hindrance to the progress of the work. A right developer having adequate experiences of underground engineering, equipped with men, materials & machineries, conversant with latest rules and regulations concerning protection of surrounding environment, having adequate fund and having training of crisis and disaster management should be entrusted for a right underground project to avoid casualties and disasters. Probable casualties in the underground project may be due to caving of soil, failures of the bracings in the braced excavation, leakage of underground utilities to get the trench inundated, seepage of water through the hone combed concrete retaining walls, bursting of base of excavation at any stage of excavation due to heaving of soil, failure of pump required for dewatering etc. The engineer at site should take prompt action by contacting the concerned authorities in case any of the above casualties occur at site and restore the normal situation in the least possible time. Any delay in restoring the normal situation will delay the completion of the project which in turn increases the cost of the project. To reduce if not eliminate the casualties the engagement of unskilled technicians and the construction workers are to be blanket banned. The wearing of

helmet, safety belt and shoes should be made mandatory in underground construction works. The builders have to provide steel ladders, cantilever platforms, longitudinal cat walk at the appropriate locations for the inspecting officials, supervisors and the construction workers.
In the developing nations a good number of skilled labours would be required in the coming years to meet the demand of the future underground construction industries. So it is the high time for the engineers' and the architects' lobby to explode the potential of these skilled labour force. For this proper training could be imparted to the unemployed mass of the rural and semi urban sectors adjoining the cities and towns to achieve the target
The Right Person to be awarded for the underground construction work.
Adequate experiences for tackling underground construction in a city or town.
Adequate fund.
Equipped with 3 M's viz. men, materials and machineries.
Knowledge of underground engineering background.
Conversant with latest rules and regulations concerning protection of surrounding environment and normal public life.
Expertise in crisis and disaster management including mitigation measures.

Basic Qualities of an Underground Construction Engineer

He should be more a professional manager than an engineer.
Superior technical knowledge and expertise.
Excellence in preserving communication skill and decision making.
IT -knowledge in engineering.
Sharing of facts, feelings, ideas, information and attitudes with the manpower engaged and involved at site.
Knowledge of outsourcing for the globally competitive hi-tech projects.
Sticking to deadlines.
Control of time and budget which is the main objective of value engineering.
Training of crisis and disaster management and mitigation measures.

Special Emphasis on the Congested City of Kolkata

Access of traffic road in Kolkata is available only to the tune of six percent or so. If the buildings and the structures on either side of the roads are demolished as viable for widening or roads, the access can be improved to ten percent or so. But the question arises whether the demolition can be actually executed. It cannot be executed because such actions will invite not only legal complication but also political compulsion. So what are the other options? The other options are to explore the feasible accesses in the city to develop the underground and over ground corridors for rail or road. The present traffic congestion of Kolkata is generating the greenhouse gases which are endangering the environment of the city resulting in the respiratory diseases of the citizens. The existing surface traffic of Kolkata is already overburdened and addition of more vehicles would worsen the congestion. So the present surface traffic system is needed to be modernised along with building infrastructure for the eco-friendly underground and the elevated corridors for rail or road. The elevated corridors can however, be multitier. Developing underground corridors for rail or road in the congested city of Kolkata, protecting all the underground dry and wet utilities in order during the construction sequences is not only troublesome but also very much cost effective. The cost of constructing deep underground corridor bypassing the utilities shall be seven to eight times that of over ground or elevated corridor depending on the alignment, grade and cushion of the underground corridor system. Moreover an elevated corridor founded on pile based piers spaced at fifteen / twenty meters center to center can be developed quickly and without much difficulty. The acquisition of land shall be needed only for the piers in isolation. So while making an environment friendly road or rail corridor in Kolkata, attempt is to be made to make the alignment partly elevated where requisite access is available and partly underground piercing the congested surface of the city. In this regard the alignment of East - West Metro alignment is justified. After the East - West Metro line is commissioned, commuters from Salt Lake or Howrah can go to Dumdum or Tollygunge / Garia or vice-versa by interchanging at the existing 'Central' Metro Station which would have double storied platforms, the top one for the existing North - South and the bottom one for the new East - West with adequate escalators.

Ideas Behind the Construction of Metro Railway in Kolkata

Despite the huge capital investment involved, the underground railway is considered the best transportation system for the metro cities because it is highly efficient, safe, comfortable, fast and it eliminate all the surface traffic constraints of the cities. The first underground railway was built in London in the year 1963. The idea of developing Metro Railway in India was conceived by Late Dr. B. C. Roy, Ex. Chief Minister of West Bengal in the year 1959 nearly after a century of building of first Metro in London.

In the present scenario, the underground railway is considered the best environment - friendly traffic among the various modes of transportation systems considering the trend of alarming air pollution of the mega cities due to climate change. Building the India's first and the world's eighty –fifth Metro Railway in a congested city like Kolkata by the Indian Railways, after waiting for decades, is no doubt a great achievement for Indian technocrats. The construction method of the 16.45 km length of Metro Railway from Dumdum in the north to Tollygunge in the south is based by and large on the cover & cut or cover & cut methodology except a km. or so over elevated alignment, about a km. by shield tunnelling to pierce beneath the bed of a canal and the rest on surface for few meters. The whole alignment of 16.45 km had been opened to traffic in stretches in the year 1984, 1986, 1994, 1995, and finally in the year 1996. The unusual delay for completing the eco-friendly project is due to financial constraint and legal complications for acquiring the land for the project. Although a hugh national investment had been sunk into the project, the Kolkata mega city has not derived the optimum benefit out of Metro Railway which was designed for passenger services of 60,000 commuters per hour in each direction, the Metro system remains underutilised due to the following reasons

(a) The existing stretch is only a linear north - south alignment without having any other metro corridor in other directions with interchange facilities in between or among the corridors.

(b) The surface transport systems are accessible to urban dwellers of the city at a cheaper rate than the fare structures of Metro Railway confined to upper crust section of middle class categories.

Presently, the Metro Railway is restricted from Dumdum to Tollygunge with seventeen stations, the terminal stations Dumdum being on elevated structure and Tollygunge on the surface at ground level.

To bring the utilisation of existing Metro Services within the reach more number of commuters the Metro Railway has been extended from Tollygunge to New Garia with further six intermediate stations at a distance of minimum 0.93 km. to maximum. 1.98 km. The terminal station of the extended Metro is New Garia which is on the surface in between the existing Baghajatin and Garia Stations on the Sealdah South Section of Easter Railway.

To avoid the delay of acquisition of land by the side of Tolly Nullah along its bank, eighty percent of the extension has been undertaken over elevated structure founded on pile based column structure of about 2 meters radius spaced at 20 meters center to center along the center line of Tolly Nullah Canal. At present the navigability of Toly Nullah (called Adi - Ganga in the legendary term) originated from the river Hooghly at Hastings. The present picture of Adi - Ganga is very pathetic. It is highly silted with insignificant flow of water in the dry season and is now used as an outfall of municipal untreated sewers and open drains. After the extended Metro corridor has been completed over the center line of the canal, option remains for a breakthrough revival of the polluted canal through proper dredging and widening to make it navigable for small water transport and bank beautification by gardening equipped with food parks, kiosks etc. The substructure of the viaduct structure is well below the bed of the canal and will not be the obstruction for navigability. The bottom of the elevated viaduct will have sufficient headroom to clear navigable modernised boats and small water launches for joy ride of Metro commuters. The obstruction is restricted to only the perimeter of the columns spaced at 20 meters center to center along the center line keeping the bays on the either side of the columns free for navigation of small passenger and commercial water vehicles.

Presently the construction of two other Metro lines in Kolkata viz East - West and Joka to Esplanade are in progress. The East - West consists of Metro route from Salt Lake (Sector V) to Howrah Maidan via B. B. D Bag with interchanging facilities at the existing Central Metro Station. The route is on elevated structure from Salt Lake to Narkeldanga and then totally by underground tunnelling eliminating cut-and-cover construction due to heavily built up areas. The special feature of the route is to cross the river Hooghly by a 500 meter or so tunnel to be constructed below the bed of the river with sufficient cushion and to suit the gradient on either side of the river. The route finally terminates at Howrah Maidan where the underground construction is on. The construction of Joka B. B. D. Bag has already undertaken which will have interchanging facilities at the existing Part Street Station. Another route viz. New Garia - Dumdum via Rubi Hospital and Nicco Park with interchanging facilities at Salt Lake and Dumdum Airport Stations the construction of which has been finalised and will be undertaken shortly. Two other Metro lines viz. Dumdum - Barasat and Dumdum - Dakhineswar - Barrackpur have been planned.

It needs no mention that if all the Metro routes as stated above are completed successfully, the commuters can go to their destination from any corner of the city and around availing different routes of Metro only utilising the respective interchanging stations.