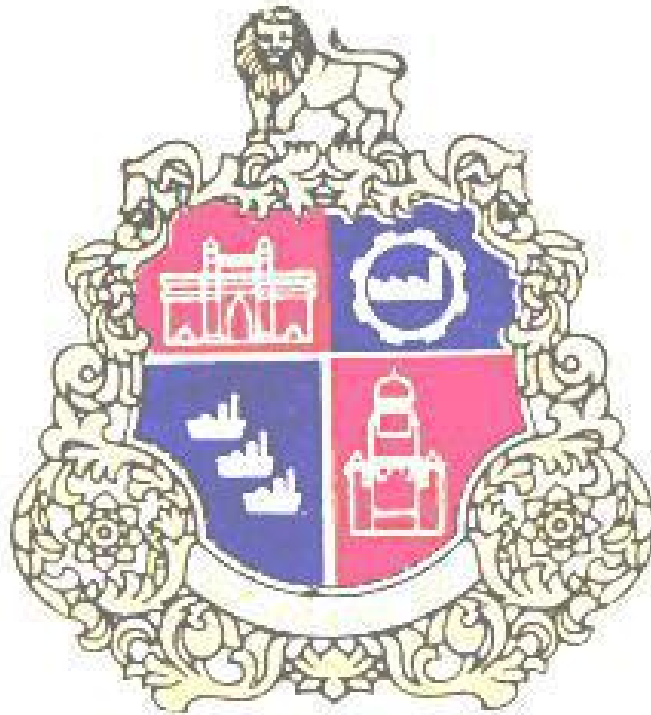


MUNICIPAL CORPORATION OF GREATER MUMBAI

STORM WATER DRAINS DEPARTMENT



VOLUME-II

**TECHNICAL SPECIFICATIONS FOR
STORM WATER DRAINS DEPARTMENT**

2018

FOREWORD



Foreword

Ever since establishment of Bombay Municipal Corporation (now Municipal Corporation of Greater Mumbai) in 1888 by the erstwhile British rulers in India, in the last 125 years of the history of its existence MCGM has catered to every aspect of the citizen of Mumbai that can be conceived of. Look to heritage buildings like Victoria Terminus (Chhatrapati Shivaji Terminus), Office of Municipal Corporation, Dadabai Naoroji Road, Dr. Babasaheb Ambedkar Road, Marine Drive (Netaji Subhash Road), Prince of Wales Museum, Gateway of India, Malabar Hill Reservoir, Nair Hospital, Lokmanya Tilak Hospital, KEM Hospital etc which are the service centers for the citizens. Municipal Services have also been provided in the suburban and extended suburban areas merged in 1950 & 1957 respectively. The obligatory duties are performed well but still there is need to improve in quantity and quality of services to be provided to the citizens.

Ethical governance and righteous work culture will certainly bring positive changes in design and implementation of projects. One may take an example of the first Municipal Head Quarter Building, that was completed in year 1893, in four years, designed by F W Stevens and the execution part was dealt by Project Engineer Shri Rao Saheb Sitaram Khanderrao Vaidya, who executed the project of 77.70m high structure and saved Rs.68,000/- as against estimated cost of Rs. 11.80 Lakhs.

The need is to work with precision and accuracy. There shall be harmony between planning and execution so as to evolve best economics with focused goals.

MCGM is one of the largest local self governments in the Asian Continent. In observance of historic traditions of strong civic activism, with the change in time and living conditions to match with the urbanization, MCGM has focused in providing variety of engineering services viz, storm water drain, sewerage, water supply, roads, bridges, solid waste management, environmental services. Beside this, the Corporation is also providing dedicated services in the Health sector by establishing Major and Peripheral hospitals.

To update and modernize the mechanism being used for working on related projects from the stage of conceptualization to execution, the need was realized to revise prevailing "Schedule Of Rates" along with specifications which were in operation with various departments and being prepared individually as per their need and revised at different span of time, resulting into various anomalies. To overcome all these, it was essential to revise the schedule of rates, not only with simple mechanized revision but incorporating major changes to keep up with the pace of urbanization, civilization, construction techniques / mechanization and voluminous developments by restructuring



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items in the schedule to cover all requirements. This exercise would provide comfort with designs and field necessities and will assist in effective checks on creation of extra items during execution.

A conscious decision has been taken to prepare Unified Schedule of Rates to keep pace with the changing time; a first step forward in this direction. Since long time, there have been demands made by the stake holders like Municipal Engineers and Contractors to remove non-uniformity, anomalies and discrepancies in various schedules of rates for work contracts of various departments of MCGM. Every department had its own expertise and way of functioning which got reflected in its independent schedule of rates, which however, had no linkage with the fair market rates and schedules of other departments, resulting into extra items and fair rates. In place of earlier 9 Schedule Of Rates, the Unified Schedule of Rates is an effort and seeks to rectify the defects, discrepancies and non uniformities which will provide ease and accuracy of estimation to the Engineers.

In view of the enormous and voluminous nature of work, keeping time frame in perspective and above all, to ensure professionalism, the work of preparation of Unified Schedule of Rates (USR) was awarded to the eminent consultants M/s. TATA Consulting Engineers Ltd. M/s. TATA Consulting Engineers Ltd were directed to conduct a integrated factual market research for major materials from stockists/manufacturers/dealers and to study schedules of rates of Govt. bodies like C.P.W.D., P.W.D. etc The new Rate Analysis are based on Factual Market research done by M/s.TATA Consulting Engineers Ltd.

The anomalies in rate are minimized after extensive market research and collection of quotations from reputed large scale stockists/dealers, and also after comparison with rates of CPWD, PWD etc.

The Unified Scheduled of Rates is linked with its comprehensive specifications of basic important activities so as to have clarity in execution. These specifications follow a chronology of general scope of the item, material required, processing of material, construction operation, finishing and mode of measurement. Rigid Standard Operating Procedures (SOPs) and complete control on processes will certainly satisfy quality parameter. The need for checking the quality of construction is quite apparent and shall be ensured throughout the construction process. To achieve this, the Unified Scheduled of Rates incorporates quality assurance procedures.

All the rates are also linked to their detailed specifications and wherever required, with drawings. Though there are about 12500 items, every item is now given a Unique Code No. which will eliminate the repetition.

It has been our endeavor to include all the necessary modern materials and technologies in Unified Schedule of Rates, for example, the concept of green building, which will go a long way to have control on creation of extra items and fair rates. A salient feature of this Unified Schedule of Rates is 'Starring of items' specified categorically which can be used only at certain works or locations.



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Another salient feature is 'Dynamic Rate System' which will be based on study of data base of quantities and bidding prices of awarded contracts on the basis of which necessary corrections can be applied to the Unified Schedule of Rates at specified intervals. The MCGM will be now be in a position to revise the Unified Scheduled of Rates every year, after incumbency period of M/s.TATA Consulting Engineers Ltd of one year, to work with and correct the system as and when necessary.

I am sure that this 'Unified Scheduled of Rates' will be a milestone in civic governance by MCGM. This publication shall be of great help and guidance to the officers engaged in the project work of MCGM.

A.M.C. (E.S.)

Municipal Commissioner



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**STORM WATER
DRAINS
SPECIFICATIONS 2018**



Municipal Corporation of Greater Mumbai

1.0 **SCOPE**

This specification covers the methodology and safe working procedures followed in carrying out desilting works of drains/nallahs in MCGM

2.0 **APPLICABLE CODES AND SPECIFICATIONS**

The following specifications, standards and codes should be considered a part of this specification.

| Sr. no | IS Code no. | TITLE |
|--------|--------------------|--|
| a). | IS 1742 - 1983 | Code of practice for Building drainage |
| b). | IS 10595 - 1983 | Requirements for power driven Bucket type drain cleaning machine |
| c). | IS 11117- 1984 | Requirement for power driven rodding machine for sewer |
| d). | IS 11387- 1985 | Requirements of high pressure jetting machine for sewer cleaning |
| e). | CPHEEO 1993 | Manual on sewerage and sewage treatment |
| f). | IS 11972 | Code of practice for safety precaution to be taken when entering a sewerage system |
| g). | IS 13496 | General requirements of suction machine for cleaning sewers, manholes |
| h). | IS 11387 | Requirements for high pressure jetting machine for sewer cleaning |
| i). | IS 11397 | Specifications for attachment tools for power driven rodding machine for sewers. |

3.0 **DESILTING OPERATION**

Desilting of pipes and culverts is required so as to maintain their hydraulic carrying capacity. The frequency of desilting depends on the pipe size, gradient, flow condition, etc. and is subject to verification by inspection results.

4.0 **TOOLS/EQUIPMENTS USED FOR DESILTING**

Desilting of drains requires major tools such as pick axes, manhole guards, tripod stands, danger flags, lantern, batteries, safety lamps, lead acetate paper, silt drums, ropes, iron hooks, hand carts, plunger rods, observation rods, shovels etc and some special equipments as mentioned in trailing paragraphs.

5.0 **METHODS FOR DESILTING**

Depending upon the size & depth of drain, spacing of manholes, length of culvert and the condition of drainage line, the following methods of desilting operation shall be used depending on circumstances.

Drainage cleaning work requires special equipments and devices like a portable pump-set operate on either diesel/petrol, manila rope and cloth balls, rods, a cleaning bucket machine, a dredge, a rodding machine with flexible rods and cleaning tool attachments such as flush bags, wooden ball, gully emptier and pneumatic plugs.

5.1. **PORTABLE PUMP SET**

In cases, where drains are blocked completely and sludge has accumulated in manholes, the accumulated sludge has to be pumped out to tackle the drain blockages. Such pumps should be of non clogging type preferably on four wheel trailers and should be provided with a self propelling unit to save time and effort. Small pneumatic pumps can be used where high lifts are required and the volume of liquid to be pumped is not large, for example when it is required to pump out flooded basements and dewatering of deep trench. In case of deep manholes, non clogging submersible pumps may be used.

5.2. **DESILTING BY MANILA ROPE & CLOTH BALL**

Cleaning drain lines upto 300 mm diameter can be done by using the manila rope and cloth ball. Flexible bamboo strip tied together are inserted into drain by a man

on top. If necessary another man inside the manhole helps in pushing the rod through the drain line. When the front end of the bamboo stripe reaches the next manhole, a thick manila rope is tied to the rear end of the bamboo splits. The bamboo splits are then pulled by another man in the downstream of the manhole and pushed through drain line. As the rope is pulled, the ball sweeps the drain line and the accumulated grit is carried to the next manhole where it is removed out by means of buckets. The operation is repeated between the next manholes until the stretch of drain line is cleaned.

5.3. DESILTING BY RODDING

These rods are used for cleaning small drains (upto 200 mm dia). The rods may be made up of bamboo or teakwood or light metal, about one meter length with coupling at the ends, which remains intact in the drain but can be easily disjoined in the manhole. Sections of the rods are pushed down the drain. The front or the advancing end of the drain rod is generally fitted with a brush along with a rubber ring for cleaning or a cutting edge to cut and dislodge the obstructions. These rods are also useful to locate the obstruction from either of the two adjacent manholes.

5.4. DESILTING BY DRAIN CLEANING BUCKET MACHINE

The bucket machine consists of two powered winches with cables in between. In cleaning a section of drain, the winches are centered over two adjacent manholes. To get the cable from one winch to the other, it is necessary to thread the cable through the drain line by means of drain rods or flexible split bamboo rods. The cable from the drum of each winch is fastened to the barrel on each end of an expansion drain bucket fitted with closing device, so that the bucket can be pulled in either direction by the machine on the appropriate end. The bucket is pulled into the loosened material in the drain until the operator feels that it is loaded with debris. The winch is then thrown out of gear and the opposing winch is put into action. When the reverse pull started, the bucket automatically closes and the dirt is deposited in a truck or a trailer. This operation is repeated until the line is clear. Various bucket sizes are available for drains 150 mm to 900 mm in size. The machine is also used along with other scrapping instruments for loosening sludge banks of detritus or cutting roots and dislodging obstructions.

5.5. DESILTING BY DREDGER

It consists of a grab bucket on a wire which is lowered into the manhole in open condition with the help of a crane and pulley. On reaching the bottom of the

manhole the segments are closed picking up the accumulated silt. The bucket is then raised above ground level where the bucket opens and the silt is automatically dropped into a truck or a trailer. The closing of the bucket can be affected by wire ropes or by a pneumatically operated cylinder. The disadvantage in this system is that it cannot clean the corner of the catch pit of manholes. Sometimes the deposits at the corners may become so hard that the same may be required to be chiseled out.

5.6. DESILTING BY RODING MACHINE WITH FLEXIBLE DRAIN RODS

This consists of a machine which rotates a flexible rod to which is attached a cleaning tool such as auger, corkscrew or hedgehog and sand cups. The flexible rod consists of a series of steel rods with screw couplings. The flexible rod is guided through the manhole by a bent pipe. The machine rotates the rod with the tool attached to one end, the other being fixed to the machine. The rotating rod is thrust into the bent pipe manually through clamps with long handles holding the rod near the couplings. As the rod is thrust inside, the machine also is drawn towards the manhole. The rod is pulled in and out in quick succession when the tool is engaging the obstructions, so as to dislodge or loosen it. When the obstruction is cleared, the rod is pulled out by means of clamps keeping the rod rotating to facilitate quick and easy removal.

5.7. DESILTING BY SCRAPER

This method is used for drains of diameter larger than 750 mm. The scraper is an assembly of wooden planks of slightly smaller size than the drain to be cleaned. Where the scraper cannot be lowered through the opening of a manhole, the scraper has to be assembled inside the manhole. The scraper chains, attached to a control chain in the manhole into which it is lowered is then connected to a winch in the next downstream manhole by means of chains. The winch is then revolved to push the debris ahead of the scraper. The heading up of the flow behind the scraper and the water dropping from the top of the scraper will also assist in pushing it in the forward direction. This ensures that the bottom and the sides of the drains are cleaned thoroughly. The scraped debris is removed manually. Circular scrapers are used on small drains below 350 mm diameter for cleaning the body of the line. They are commonly known as discs and these discs are either of collapsible type made out of metal or a wooden pair separated about 200 mm apart by steel rods.

5.8. HYDRAULICALLY PROPELLED DEVICES

The hydraulically propelled devices take advantage of the force of impounded water to effectively clear drains. Efficiency depends on the hydraulic principle that an increase in velocity in a moving stream is accompanied by a greatly increased ability to move entrained material. The transporting capacity of water varies as the sixth power of its velocity.

5.9. DESILTING BY VELOCITY CLEANERS (JETTING MACHINE)

The high velocity drain cleaner makes use of high velocity water jets to remove and dislodge obstructions, soluble grease, grit and other materials from sanitary, storm and combined drainage systems. It combines the functions of a rodding machine and gully emptier machine. Basically it includes a high pressure hydraulic pump capable of delivering water at variable pressure up to about 80 kg/cm² through flexible hose to a drain cleaning nozzle. The nozzle has one forward facing hole and a number of rear ward facing holes. The high pressure water coming out of the holes with a high velocity breaks up and dislodges the obstructions and flushes the materials down the drain. Moreover by varying the pressure suitably, the nozzle itself acts as jack hammer and breaks up stubborn obstructions. (A separate suction pump or air flow devices may also be used to suck the dislodged material). The entire equipment is usually mounted on a heavy truck chassis with either a separate prime mover or a power take off for the suction device. The high pressure hose reel is also hydraulically driven. The truck also carries fresh water tanks for the hydraulic jet and a tank for the removed sludge and the various controls grouped together for easy operation during drain cleaning. The manufacturer's operating and servicing manuals should be carefully followed for best results in the use of the machine.

5.10. SUCTION UNITS (GULLY EMPTIER)

Suction units create vacuum required for siphoning of mud, slurry, grit and other materials from sanitary, storm and combined drainage systems. The vacuum created is such as to siphon the materials from the manholes, catch pits etc., having depth ranging from 1 m to 8 m in normal cases with an option to suck additional 4 m with the help of special accessories for the purpose. The unit can be vehicle or trolley mounted. Slit and heavy particles settled at the bottom can be agitated and loosened by pressurized air with the help of the pump and then sucked in a tank. Once the silt tank is full, the effluent is discharged in the nearby storm water drain or manhole, and the operation is repeated till the manhole is

cleared off the silt. The silt deposited in the tank is then emptied at the predetermined dumping spot. This machine is very much useful in desilting surcharged manholes and in routine course the manholes can be silted without the workers getting down into the manhole.

5.11. PNEUMATIC PLUGS

The plugs are used for isolating the gravity drains for low pressure testing of drains, Stopping the flow of drainage in the drain line to carry out structural repairs and stopping the flow to carry out routine maintenance on the downstream side of plugged drain line. The plugs are made of metal plates which can withstand the action of waste water. The plates are bounded with suitable quality strong elastic materials. The plugs should withstand the minimum hydrostatic back pressure likely to be encountered. The plugs can be inflated and deflated within the drain line itself by suitable controls from the road level. Suitable hook and chain are provided to chain the plug in the manhole. Tethering life line and inflation hose are supplied with each plug. All plugs above 450 mm diameter should have a bye pass fitting suitable for fixing a fire hose and suction hose.

6.0 PRECAUTIONARY MEASURES

Following precautionary measures to be taken by the Contractor for the safety and welfare of the labours connected with desilting work.

- 6.1. To begin with the work of desilting, initially six consecutive manholes are to be opened two on the upstream and two on the downstream side of the two manholes, on the actual stretch to be cleaned or desilted. The manholes should be kept open for one hour prior to the starting of cleansing operations and should be so kept open during the whole duration of cleaning operations. This to be done for allowing the combustible gases to escape naturally.
- 6.2. Particular care should be taken where drain is heavy silted. The scum and sullage shall be thoroughly stirred and disturbed by means of long bamboos from the top of the manhole to allow entrapped gases within silt pockets to escape before allowing the labourers to go down into the manhole. The depth of water should be measured and the labourer should be asked to get down when the water level is less than 60 cm from bottom.

- 6.3. Allow no smoking or open flames and guard against sparks. This may cause fire and explosions endangering the life of the workmen and the pedestrians.
- 6.4. Erect warning signs.
- 6.5. Use only safety gas-proof electric lighting equipment.
- 6.6. Test the atmosphere for noxious gases and oxygen deficiencies.
- 6.7. If the atmosphere is normal, workmen may enter with a safety belt attached and with two men available at the top. For extended jobs, the gas tests shall be repeated at frequent intervals depending on circumstances.
- 6.8. If oxygen deficiency or noxious gas is found, the structure shall be ventilated with pure air by keeping open at least one manhole cover each on upstream and downstream side for quick exit of toxic gases or by artificial means. The gas tests shall be repeated and the atmosphere cleared before entering. Adequate ventilation shall be maintained during this work and the tests repeated frequently.
- 6.9. If the gas or oxygen deficiency is present and it is not practicable to ventilate adequately before workers enter, a hose mask shall be worn and extreme care taken to avoid all sources of ignition. Workers shall be taught how to use the hose equipment. In these cases, they shall always use permissible safety lights (not ordinary flash lights), rubber boots or non-sparking shoes and non-sparking tools.
- 6.10. Workmen descending a manhole shaft to inspect or clean drains shall try each ladder step or rung carefully before putting the full weight on it to guard against insecure fastening due to corrosion of the rung at the manhole wall. When work is going on in deep drains, at least two men shall be available for lifting workers from the manhole during emergency (at the time of serious injury).
- 6.11. Portable air blowers, for ventilating manhole, are recommended for all tank, pit or manhole work where there is a question as to the presence of noxious gas, vapors or oxygen deficiency. The motors for these shall be of weatherproof ,flameproof types and compression-ignition-diesel type (without sparking plug) may be used. When used, these shall be placed not less than 2 m away from the opening and on the leeward side protected from wind so that they will not serve as a source of ignition for any inflammable gas which might be present. Provision should be made for ventilation and it should be of the forced type which can be provided by blower located at ground level with suitable flexible ducting to displace out air from the manhole.
- 6.12. Before the labourer is allowed to get down inside the manhole he should be asked to apply coconut oil all over the body as precautionary measures to safe guard against itching and burning sensation.

- 6.13. Not less than two people should be allowed to work inside the manhole at a time. They should always be sent in pairs. The labourers should not be asked to work for more than one hour at a time inside the manhole.
- 6.14. Whenever it is required to enter the body of the sewer line for more than 1.5 meter length a gas mask should be worn by the workman fitted with equipment for supplying fresh air. No person should be allowed to enter without the above gas mask
- 6.15. The labourers who are working inside the manhole should give jerks very few minutes to signify that everything is alright with them. If some or all the steps do not exist in the manhole, the labourer should go down with the help of 50 mm. thick rope.
- 6.16. There should be arrangements for storing water, etc., and the labourers should be asked to take bath after the work is over.
- 6.17. In cold seasons i.e., November 15, to January 31st, there should be sufficient supply of fire wood to labourers for warming up after bath.
- 6.18. Contractor should provide carbolic soap at the rate of one cake for four days and washing soaps at the rate of one cake for four days for washing clothes of labourers. Labourers should be asked to take bath after the work is over and while cleaning operation is done.
- 6.19. Always keep "first aid box, helmets and gas masks at the site of works."

7.0 **TESTS**

- 7.1. Lead acetate paper wetted and tied to a string be lowered down to a depth of about 30 cm above the level of the water and should be kept there for 3 to 4 minutes. It should be taken out and seen if the lead acetate paper which is originally white in color tends to turn black fully or partially, it indicates the presence of hydrogen sulphide gas. More time should be allowed for ventilation. In the alternative portable air blowers should be operated to below in there air keeping the hose pipe inside the manhole for sufficient time.
- 7.2. Lead acetate paper tests should be taken until the absence of H₂S is fully indicated.
- 7.3. After each tests date and time should be written on the lead acetate paper with signature of Mukadam or contractor's representative. The site supervisor also checks and initials it at the time of his visit.
- 7.4. Later a Davy's safety lamp should be lowered down right upto the haunches of the manhole. If the flame does not flicker, it indicates absence of methane, or other combustible gases.

- 7.5. After the presence of combustible gases is ruled out the following further test is required to be carried out for the presence of oxygen.
- 7.6. A lighted naked candle placed at the center of the candle testing equipment covered with glass on three sides should be lowered down slowly. If the flame is extinguished or if flicker, it indicates the presence of carbon-monoxide and or carbon dioxide. If it burns for not less than five minutes uniformly, it indicates the presence of oxygen which is required for breathing or the workman working inside the manhole.

8.0 **DIVER**

- 8.1. The contractor should keep sufficient number of divers capable of holding the breath for more than three minutes at a stretch. The diver should be able to go inside the stagnant manhole when there is 4.5 meter. Depth of water so as to remove any obstruction on the mouth of the pipe at upstream or downstream of manhole or to fix the G. I. pipe or operating the choke machine or to guide the nozzle of the air compressor pipe or for any other purpose. All the facilities that are given to labourers are required to be given to the Diver also. Sufficient cotton and eucalyptus oil should also be made available to him before diving.
- 8.2. Contractor should maintain a muster of all the labourer working at site and his supervisor should prepare a triplicate copy of the same specifying the persons getting down the manhole and send one copy to the site. Engineer and another copy to the Assistant Engineer or Executive Engineer who is in charge of the works and third copy should be kept in his office for his record. He should also take measurements along with the Site Engineer of the silt removed immediately after the work is closed for the day and prepare the same measurement record in triplicate. The contractor should give one copy to site Engineer and he should send one copy to the Assistant Engineer or Executive Engineer the copy of both of these should reach the A.E. or Ex. Engineer on the next working day before 11 A.M. without any extra cost.
- 8.3. The contractor should also see that the silt is transported within 24 hours to the Dumping ground or to the site wherever directed by the Asstt. Engineer or Executive Engineer. If the contractor fails to remove the same within 24 hours the same will be removed by the Corporation at risk and cost of contractor after the contractor is informed in writing.

- 8.4. The contractor should not make the silt depot etc. near the water gully. If it is found that he has done it and blocked the water gully, the same will be got cleaned departmentally at the risk and cost of the contractor.
- 8.5. Contractors should make depot at places having least obstruction to traffic. Depots should not be made near to junctions or near school or at any other place directed by the Ex. Engineer. All the silt removed from manholes near Bus stop or junctions should be transported immediately to a place approved by the Ex. Engineer within 100 meters from the manhole. No extra payment on this account will be made.
- 8.6. While removing silt from catch pit the Municipality will provide sluice gang to close the inlet and outlet and the flow will be diverted through by pass and the gang will see that leakages etc. are stopped with puddle provided by the Corporation. However the responsibility of dewatering the catch pit by providing sufficient number of pumps of sufficient capacity lies with the contractor.
- 8.7. Nothing extra will be paid to the contractor for pumping out water depth from 1.8 meter to 2.4 meter. In such situation the workmen who are holding the rope should be alert to pull up the workmen working inside catch pit to the top immediately within a few seconds after they get signal from the workmen working below that the water is raising rapidly.
- 8.8. No person other than the contractor's labourer should be allowed to go inside the manhole. If it is found that any unauthorized person has entered the manhole and is injured or dies the contractor will be responsible for damages etc. claimed by the person or his heirs. As far as possible the Municipal Corporation will try to maintain the working levels inside the manhole where desilting work is being done. If this is not possible due to some sudden exigencies like high tide times, pumps getting out of order, power failure or due to any other reason nothing extra will be paid on this account.
- 8.9. Air blowers bucket winching or any other mechanical equipment agitators or Air compressors will be allowed to be used for removing silt for which nothing extra will be paid. Municipal Corporation is having desilting equipment and it will be made available to the contractor on hire basis, if it is not being used elsewhere by the Corporation Arrangements for transporting the equipment etc. are to be made by the contractor.
- 8.10. Even though the contractors taken all the precautionary measures and by chance any work man is injured or dies due to negligence or otherwise the contractor will be responsible for the claims of damages by the workman or his heirs.

9.0 MEASUREMENT AND PAYMENT

- 9.1. The measurement for desilting of open drain/nalla shall be on cubic meter (Cu.m)
- 9.2. Desilting of pipe drain of diameter 230 mm to 1200 mm shall be measured on running meters of pipe length.
- 9.3. Payment will be made on the basis of unit rates quoted for respective items in schedule of quantities.
- 9.4. For payment purpose 30% will be deducted for voids in silt and 40% for stones and boulders on depot measurement.

END.



बृहन्मुंबई महानगरपालिका

1. SCOPE

1.1. This specification covers general requirements of all types of manholes, considerations for manholes and their construction and safety requirements.

2. GENERAL

2.1. At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be 30 m.

3. LIST OF IS CODES

| Sr. | IS Code No. / Year | Title |
|-----|-----------------------------|---|
| 1 | 456 -2000 | Code of practice for plain and reinforced cement concrete |
| 2 | 458-1971 | Concrete pipes |
| 3 | 516-1959 | Methods of test for strength of concrete |
| 4 | 651-1981 | Salt-glazed stoneware pipes and fittings |
| 5 | 783-1985 | Code of practice for laying of concrete pipes |
| 6 | 784-1978 | Pre-stressed concrete pipes |
| 7 | 1726 (part 1,2 & 4) | Cast iron manhole covers and frames - Specification |
| 8 | 4111 (part 1-4) | Code of practice for ancillary structures in sewerage systems |
| 9 | Code | National Building Code of India |
| 10 | 12592(Part 1)-1988 | Specification for precast concrete manhole covers and frames- Covers |
| 11 | 12592(Part 2)-1991 | Specification for precast concrete manhole covers and frames -Specification |
| 12 | 1865: 1991(Reaffirmed 2005) | Iron castings with spheroidal or nodular graphite-Specification |

| | | |
|----|----------------------------|--|
| 13 | 5455-1969(Reaffirmed 2003) | Specification for Cast Iron Steps for Manholes |
| 14 | 210:2009 | Cast Iron Castings –Specification |
| 15 | 5455-1969(reaffirmed2003) | Specification for Cast iron steps for Manholes |

4. **SIZE OF MANHOLES**

- 4.1. Manhole shall be of such size as will allow necessary cleaning and inspection of manholes.
- 4.2. Conical Manhole:- The circular manholes can be provided for all depths starting from 0.9m. Circular manholes are straight down in lower portion and slanting at top portion so as to narrow down the top opening equal to internal dia of manhole cover. The internal diameter of circular manholes shall be kept as following for varying depth.
- For depths upto 2.30m, 1.2m diameter
 - For depths above 2.30m and upto 9.0m, 1.5m diameter
 - For depths above 9.0m and upto 14.0m, 1.8m diameter
5. When the diameter of outgoing pipe is more than the diameter of incoming pipe, the crown of the incoming and outgoing pipes shall be fixed at the same level and necessary slope is given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the entering sewer may be fixed at lower level but in no case the peak flow level of the two pipes shall be matched.
6. Sewers of unequal sectional area shall not be joined at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least $\frac{2}{3}$ the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

7. **EXCAVATION**

- 7.1. The excavation for manhole shall be true to dimensions and levels shown on the plans or as directed by the Engineer-in-Charge. The excavation of deep manholes

shall be accompanied by with safety measures like timbering, staging etc. (Ref. specification from common schedule). in areas where necessary, appropriate measures for dewatering should be made.

8. **BED CONCRETE**

8.1. The manhole shall be built on a bed of cement concrete of grade M-15 i. e. 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 40 mm nominal size) unless required by local authorities. The thickness of the bed concrete shall be 300 mm for manholes unless otherwise specified or directed by the Engineer-in-Charge. In case of weak soil, special foundations as suitable shall be provided.

9. Manholes may either be constructed in brickwork or reinforced cement concrete work.

10. **BRICK WORK**

The brick work shall be with first class bricks in cement mortar 1:2 (1 cement: 2 coarse sand). All brick work in manhole, chamber and shaft shall be carefully built in English bond, the jointing faces of each brick being well buttered with cement mortar before laying, so as to ensure full joint. The construction of wall in brick work shall be in accordance with the specification no. (Common schedule). The external joints of the brick masonry shall be finished smooth, and the joints of the pipes with the masonry shall be made perfectly leak proof. For arched type and circular manholes, brick masonry in arches and arching over the pipes shall be in cement mortar 1:2 (1 cement: 2 fine sand). In the case of manholes of circular type the excess shaft shall be corbelled inwardly on three sides at the top to reduce its size to the cover frame to be fitted. The walls shall be built of one brick thickness for depths up to 2.3 m. one and half brick length for depths 2.3m to 5.0m, two brick length for depth 5.0m to 9.0m.

11. **PLASTER**

11.1. The walls of the manholes shall be plastered inside and outside with 20 mm thick cement plaster 1:1 (1 cement: 1 coarse sand) finished smooth. Where the saturated soil is met with richer mix may be use and the plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per

manufacturer's specifications. For earth work excavation, bed concrete brick work, plaster and pointing, R.C.C. work and refilling of earth, respective specifications from common schedule shall be followed.

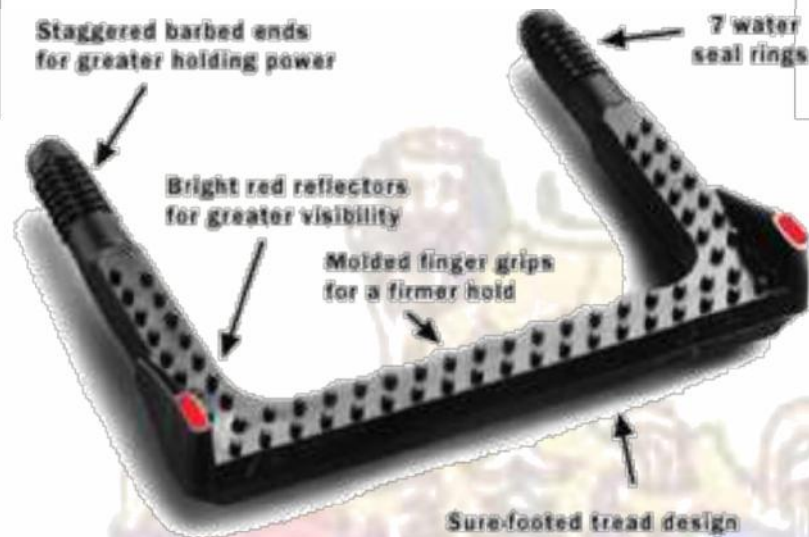
12. CHANNELS AND BENCHING

- 12.1. These shall be semi circular in bottom half and diameter equal to pipe. Above the horizontal diameter sides shall be extended vertically 50mm above the crown of pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to benching but at their junction with main channel, an appropriate fall, if required suitably rounded off in the direction of flow in the main channel. The channels and benching shall be done in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth with neat cement.

13. SAFETY STEPS

- 13.1. All manholes deeper than 0.8 m shall be preferably with foot rests made of cast iron or material approved by engineer in charge. These steps shall be set staggered in two vertical runs, which may be 300mm apart horizontally as well as vertically and shall project a minimum of 100mm beyond the finished surface of the manhole wall. The top rung shall be 450mm below the manhole cover and the lowest not more than 300 mm above the benching. The foot rest shall be painted with coal tar; the portion embedded in masonry on concrete block shall be painted thick cement slurry before fixing.

13.2. COPOLYMER STEPS



- a) Minimum 3 mm thick Polypropylene copolymer is injection moulded around a 12 mm dia tor-steel bar
- b) Orange Color
- c) Minimum overall length of 260 mm and width of 165 mm
- d) Protruding legs have a 2 mm tread on top surface by dots for providing an antiskid surface
- e) Designed to withstand the bend test and chemical resistance test as per specification
- f) Polypropylene copolymer conforming to ASTM D-4101/IS-10910
- g) 12 mm dia Fe-415 Steel reinforcement conforming to IS - 1786

13.3. **INSTALLATION:** Once the concrete is cured, the manhole step can be driven into two 25 mm diameter parallel pre-formed holes or drilled holes, 137 mm center to center, 135 mm deep or in case of installation in brick wall the footrest can be placed in the brick wall during its construction.

14. **MANHOLE COVERS AND FRAMES**

14.1. For manhole exceeding 0.9m depth, size of clear opening for manhole shall be 560mm diameter. The frame of manhole shall be firmly embedded to correct alignment and levels in R.C.C. slab or plain concrete as the case may be on the top of the masonry. After completion of the work, manhole covers shall be sealed by means of thick grease. The details of different types of frames and covers are covered under the specification nos. SP-SWD-3.

15. CONSTRUCTION OF CONCRETE MANHOLE

- 15.1. Where cast in situ or reinforced concrete tube manholes are to be built in the position shown on and in accordance with the details in the approved drawings, all in situ concrete walls, slabs etc. shall be in Class M-30 sulphate resisting cement concrete.
- 15.2. The Chamber and shaft rings may be supplied in effective length of 600 mm, 900 mm. and 1500 mm. and each section will be provided with lifting holes. The tapers to be used will also have an effective length of 600 mm. The joints between the sections shall be of ogee form and the Contractor shall set each section accurately in position making the ogee joint with cement mortar to form a water tight joint. Before completion of the manhole all the lifting holes, ogees and other joints shall be neatly pointed.
- 15.3. The reinforced concrete slabs covering the chambers and the shafts of the manholes shall be set and jointed in sulphate resisting cement mortar to form water tight joints.
- 15.4. At all points where pipes are built into concrete walls or floors, great care shall be taken that the joint is water tight, if found to be otherwise, the concrete shall be cut away and replaced with concrete, all at the contractor's expense to make a water tight joint to the satisfaction of the Engineer.
- 15.5. Channels and benching to the concrete floors of the manholes for sewers upto 600 mm. diameters are to be formed as detailed in M-15 sulphate resisting concrete. In large diameter sewer manholes the benching and channels shall be cast and formed in M-15 concrete and the surface of the benching and channel finished with 75 mm. thick M-15 sulphate resisting cement concrete.
- 15.6. Manhole covers and frames are to be set in cement mortar and surrounded with M 150 concrete and cover left flush with the surrounding ground or road surface as the case may and shall be set on two courses of 230 mm brickwork. The fine adjustment of cover levels shall be effected by increasing courses of hard burnt tiles. Care shall be taken to ensure that the cover is level with and sloped to any fall or grade in the surrounding surface.

16. CONSTRUCTION OF BRICK MANHOLE

- 16.1. The walls of the manholes shall be built in brick work in cement mortar 1:2 and walls and the cap is plastered both from inside and outside with cement plaster 1:1 In the case of conical manholes, the walls shall be brought upto within 450 mm

below the road surface over which 300 mm. thick concrete cap of M-20 conical shape as shown in the drawing shall be constructed and shall be covered over with approved cover and frame as shown in respective drawing or as directed in engineer in charge. The cover with frame shall be fixed in M20 Grade of concrete for normal case however on the roads having heavy axle loads or heavy traffic, The cover with frame shall be fixed in M30 Grade of concrete (for such cases, difference in M30 & M20 cost shall be paid separately.) Where rectangular manholes are to be constructed the brick walls shall be brought up within 100 mm. to 150 mm. as required, of the road surface and shall at this depth be covered over with a reinforced cement concrete slab with an opening of the site and in the position as directed by the Engineer. The opening shall be formed by means of joists of sizes as shown on drawing resting on the side wall & embedded in the slab on these joints support walls of brick in cement shall be erected and brought upto within 450 mm of the road surface where they shall be covered with the frame and cover as per the drawing, etc., as described above. The work shall be properly bedded and the courses brought up in a regular and uniform manner.

17. **MEASUREMENTS**

- 17.1. Manholes shall be enumerated under relevant items. The depth of the manhole shall be reckoned from the top level of manhole cover to the invert level of channel. The depth shall be measured correct to an m. The extra depth shall be measured and paid as extra over the specified depth.

18. **RATE OF A MANHOLE**

- 18.1. The rate to be quoted in the Bill of Quantities for the manholes shall include complete masonry structure concrete cap plastered with cement both inside and outside bottom concrete and channel or channels with the frame and covers, C.I. Sheets, etc., everything complete as per type design drawing including (75 mm x 75 mm) vata around the extended wall at its junction with the bedding and including cutting the pipes flush with the inside plaster of the wall flush without excavation. (Excavation shall be paid under relevant item).

19. **DROP ARRANGEMENT**

- 19.1. The rate for providing 150 mm. 230 mm. 300 mm. dia. vertical drop arrangement 0.60 M. high in manholes with drop arrangements will include:-
- Providing 150 mm., 230 mm., or 300 mm. dia. S.W. Pipe of required length embedded in the masonry of the manholes at the upper and lower ends of the drop arrangement.
 - Providing and fixing 1 No. 150 mm. 230 mm. or 300 mm. S. W. right angled bend and 1 No. 150 mm. x 150 mm x 150 mm, 230 mm x 230 mm x 230 mm or 300 mm x 300 mm x 300 mm. S.W. double Tee junction including cutting the ends if require and jointing and filleting as specified.
 - 1/2 brick thick 1:2 brick masonry encasement all round with extra brick work below the bend upto the excavation level of manhole and that in the tapering portion of the manhole including curing and finishing smooth with cement plaster 20 mm. thick 1:5.
 - Plugging the open mouths of the double Tee junctions and house connection pipes wherever directed so as to make them watertight.
- 19.2. The rate for extra each meter height of 150 mm or 230 mm or 300 mm vertical drop arrangement shall include the following.
- Providing 150 mm, 230 mm, 300 mm S.W. pipes including cutting, jointing, filleting, etc., all complete.
 - 1/2 brick thick 1:2 brick masonry encasement all round including cutting and finishing smooth the exposed surface with cement plaster 20 mm. thick 1:3
 - For the payment of the items of vertical drop arrangement the height will be measured from the invert of the right angled bend to the invert of the sewer or house connection that is being dropped 600 mm. height being paid under the item of "Providing arrangement and the remaining height under the item of Extra per Meter height of drop arrangement."
 - In case of drop arrangement above 300 mm. dia. the class of R.C. pipe used shall be NP2 class. It shall consist of right angled bend of required diameter and double "T" junction. It will be surrounded by 1/2 brick thick masonry (1:2) encasement all round with extra brick below etc. as mentioned above.

20. **GUIDELINES FOR CONSTRUCTION OF ADDITIONAL MANHOLE**

Additional manhole is constructed on the sewer line so as to facilitate:-

- 20.1. Cleaning the body of the sewer if the length between manholes is more than 30 M.
- 20.2. To eliminate the body connection by constructing the manhole at the above place so as to eliminate frequent chokes.
- 20.3. The purpose of constructing additional manhole is to facilitate cleaning of the manhole and remove the silt upto the invert level and to facilitate removing silt from the body of the sewer by manually or by operating winching machines or to facilitate passing disc or operating acquitter or compressor or jetting machines or by any other mechanical means.
- 20.4. To serve the above purpose, manholes should be constructed right upto the invert level of the sewer. For this purpose excavation is to be done upto the foundation level by the side of the pipe or ovoid sewer without damaging the pipe or ovoid sewer. In pipe sewer, sufficient bedding of concrete should be placed and walls should be constructed of standard thickness on the foundation upto the top of road level as per standard design or circular manholes. In ovoid sewer, walls should be constructed upto the top of the arch and concrete beams should be provided above the ovoid sewer in a rectangular shape, so that the weight of masonry above does not fall on the arch of ovoid sewer, and walls should be constructed upto road level as per standard design of a rectangular manhole (including steps). After all the plaster work is done and frame and covers are fixed above usual 0.30 M thick concrete block, the top of the pipe or the ovoid sewer should be broken. This should be done by some person standing on top of the road level road level, by using long crow bars or by heavy weight fixed at the bottom or by some other mechanical device. As getting inside the manhole and breaking with sledge hammer or chisel may cause sudden rise in level of water or poisonous gas may come out suddenly and may endanger the life of the workman.
- 20.5. After sufficiently big hole is made in the arch of pipe, four manholes should be kept open in the stretch where manhole is to be constructed, two on upstream side and two on down steam side. The manhole cover should be kept open for an hour and tests be carried out viz., Davy's safety lamp, lead acetate paper test and candle test. After the tests are successful, another workman should get down in the newly constructed manhole preferably when the channel condition is seen on the manhole upstream or downstream side. He should apply coconut oil all over body and after tying rope around his waist and the other end held by another workman at

the top of the workman should get down the manhole and chisel the pipe ends arches ends so that the same is in flush with the wall of the manhole. Plaster in cement mortar 1:3 or if a big gap is there, concrete should be placed over exposed surface. (1:1 1/2:3 C.c.)

- 20.6. The manhole should then be cleared off all debris etc. and handed over to respective Sewerage Operation offices. In city if the manholes are constructed above main sewer it should be shown to staff of Dy.Ch.Eng.(S.O.) before handing over to the Ward Office, or concerned authorities.
- 20.7. No utility service should be allowed to remain inside the manhole. Care should be taken to shift the same outside manhole. After completing the work, the same should be handed over to concerned Dy.Ch.Eng.(S.O.) for maintenance a copy of the memo, acknowledging the taking over should be handed over to respective E.E.(S.P.)Construction.

21. **BODY MANHOLE**

- 21.1. In the event of constructing body manhole on existing functioning or non-functioning sewer line, no additional cost for breaking existing sewer pipe, breaking any encasement, construction of brick masonry pardi, dewatering, desilting etc. will be paid.

22. **FLOORS AND HALF CHANNEL PIPES**

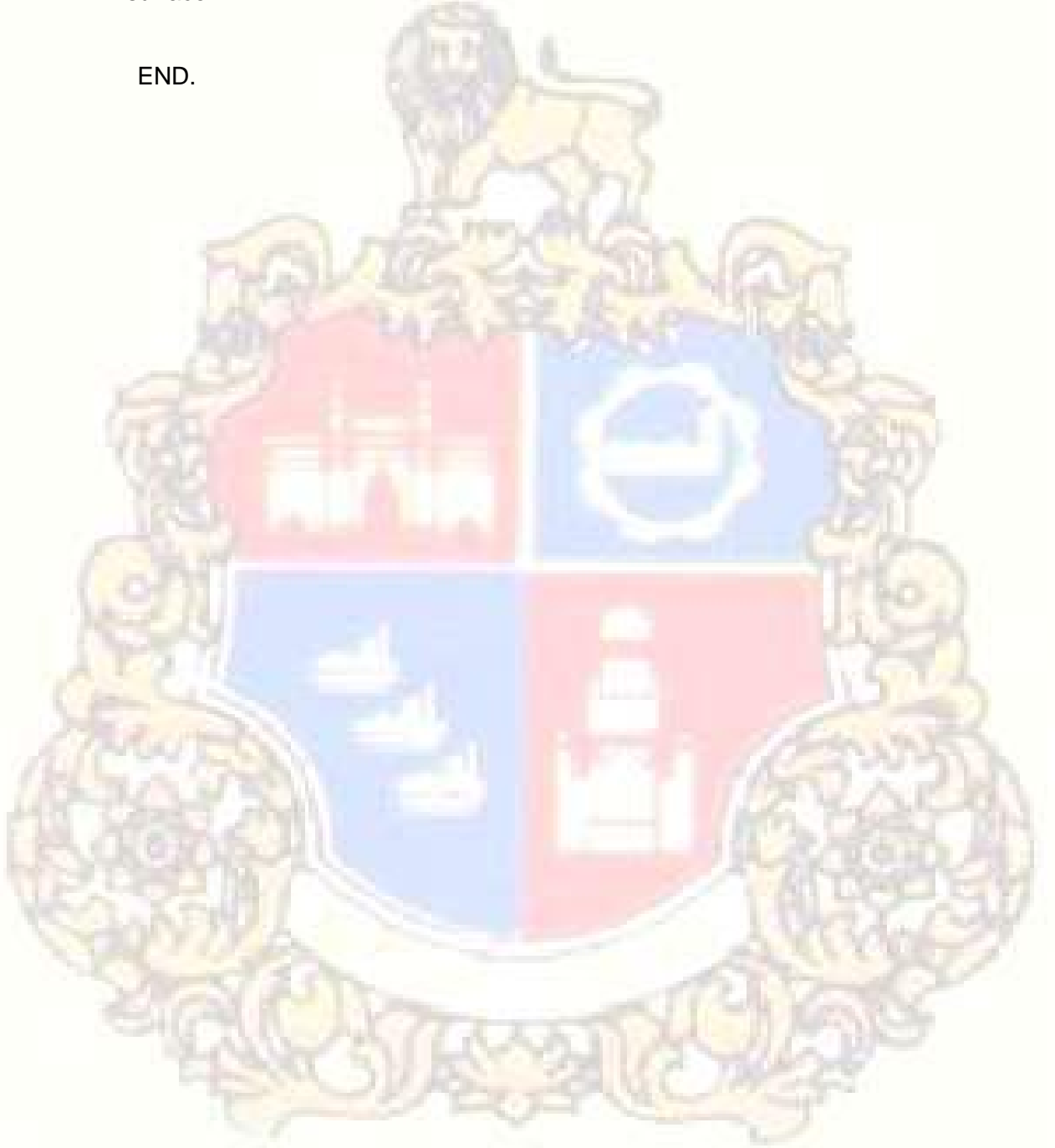
- 22.1. The floors shall consist of cement concrete. Salt glazed or concrete or R.C. half channel pipes of the required size and curves shall be laid and bedded in cement on the concrete base to the same line and fall as sewers unless otherwise directed. Both sides of the channel pipes, shall be benched up in concrete and rendered in cement mortar 20 mm. thick and formed to a slope of not less than 1 in 12 to the channel.

23. **PIPE ENTERING AND LEAVING MANHOLE**

- 23.1. Whenever a pipe enters or leaves, manholes, bricks on edge laid around the upper half of the pipe so as to form an arch. All around the pipe, there shall be a joint of cement mortar 13 mm. thick between it and the bricks and or cement concrete. The

ends of all pipes shall be properly built in and neatly finished off with cement mortar. The pipe projections are to be cut so that the ends are flush with plastered surface.

END.



बृहन्मुंबई महानगरपालिका

1.0 **SCOPE**

- 1.1. This specification covers general requirements of all types of Manhole Covers and Frames/ Gratings and Frames, specifically used for storm water drain works.

2.0 **APPLICABLE CODES AND SPECIFICATIONS**

- 2.1. The following details, standards, and codes are part of this specification. All standards, specifications and codes of practice referred to herein shall be the latest edition including all applicable official amendments and revisions.
- 2.2. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

| Sr. | Standard Code No. / Year | Title |
|-----|--------------------------|---|
| 1 | 456 -2000 | Code of practice for plain and reinforced cement concrete |
| 2 | 1726-1971 | Cast iron manhole covers and frames- specification |
| 3 | 12592:2002 | Precast concrete manhole covers and frames- specification |
| 4 | EN 124 : 1994 | Gully tops and manhole tops for vehicular and pedestrian areas- Design requirements, type testing, marking, quality control |
| 5 | 1865:1991 | Iron castings with spheroidal or nodular graphite- specification |
| 6 | 7754:1975 | Methods of designation of graphite in microstructure of graphite in cast iron |
| 7 | 210:2009 | Cast Iron Castings –Specification |
| 8 | 2046 | Code of practice for selection, Installation and maintenance of Sanitary appliances. |
| 9 | 383 | Specification for coarse and fine aggregates from |

| | | |
|----|------|--|
| | | natural sources for concrete. |
| 10 | 432 | Specification for mild steel and medium tensile steel bars and hard drawn steel wires for concrete reinforcement.(Parts 1 & 2) |
| 11 | 1786 | Specification for high strength deformed steel bars and wires for concrete reinforcement. |
| 12 | 1566 | Specification for hard drawn steel wire fabric for (Parts II) concrete reinforcement. |
| 13 | 9103 | Specification for admixtures for concrete. |
| 14 | 4082 | Recommendations on stacking and storing of construction materials at site. |
| 15 | 7969 | Safety code for handling and storage of building materials. |

3.0 **MANHOLE COVERS**

3.1. The covers and frames shall conform to IS 1726 for cast Iron, IS 12592 for pre-cast concrete covers and SFRC, FRP, DI covers and frames shall conform to EN 124. The selection of the appropriate class/grade is the responsibility of the designer. Where there is any doubt, the stronger class should be selected.

The following classification is applicable to all types of covers with frames and grating with frame having circular, rectangular and square shapes used for storm water drainage be of the following grades with recommended placing locations.

| Grades | Grade Designation | Test load (tonne) | Suitability |
|------------|-------------------|-------------------|------------------------------|
| Light Duty | LD - 2.5 | 2.5 | Only for pedestrian traffic. |

| | | | |
|------------------|----------|----|--|
| Medium Duty | MD - 10 | 10 | Only for medium vehicular traffic with axle load less than 5 tonne. car parks or car parking decks. |
| Heavy Duty | HD - 20 | 20 | Suitable for use in institutional/commercial areas/ carriageways/ city trunk roads/ bus terminals with heavy for heavy vehicular traffic with axle load between 5 to 10 tonne. |
| Extra Heavy Duty | EHD - 35 | 35 | Only for heavy vehicular traffic with axle load between 11.5 tonne. Suitable for use on carriageways in commercial; industrial/port areas/near warehouses/godowns where frequent loading and unloading of trucks/ trailers are common, with slow to fast moving vehicular traffic. |

3.2.Manhole covers and frames, gratings conforming to EN 124 are classified as follows:

| Class | Test load in | | Recommended Places of installation |
|-------|--------------|-------|--|
| | kN | tonne | |
| A15 | 15 | 1.5 | Only for pedestrian, cyclist traffic. |
| B125 | 125 | 12.7 | Footways, pedestrian areas and comparable areas, car parks or car parking decks. |
| C250 | 250 | 25.5 | For gratings installed in the area near kerb on roads at maximum extend of 0.5m on road. |
| D400 | 400 | 40.8 | Carriageways of roads, parking areas for all types of road vehicles |
| E600 | 600 | 61.2 | Docks, aircraft pavements. |
| F900 | 900 | 91.7 | Aircraft pavements with particularly high wheel loads. |

3.3. CAST IRON MANHOLE COVERS AND FRAMES

3.3.1. The covers and frame shall be manufactured from appropriate grade of grey cast iron not inferior than FG150 grade of IS 210.

3.3.2. Castings shall be straight, regular and true in every respect. They shall be clean, sound and free from porous space sand/air holes, cold shuts, warping and plugging.

3.3.3. Covers shall have on its operative top a raised chequered design to provide an adequate no-slip grip. The rise of chequers shall be not less than 4 mm.

3.3.4. Key holes, keys and lifting devices shall be provided in the covers to facilitate their placement in the frames and their operative maintenance.

3.3.5. Bituminous coating for covers and frames

The covers and frames shall be coated with materials having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to temperature of 63°C and shall not be so brittle as to chip off at temperature of 0°C.

3.3.6. The size and shape and performance requirement of manhole covers and frames shall conform to IS 1726.

3.3.7. Frame Seating area

The bearing area shall be designed in such a way that: a) the bearing pressure in relation to the test load shall not exceed 7.5 N/mm²; and it should provide an adequate contribution to stability under working conditions. Minimum 50mm frame seating is recommended if it is fulfilled requirement of structural design of the specified frame supporting concrete (i.e. M20).

3.3.8. Marking

All manhole covers and frame shall be casted with the following information marked on them:

- a) Manufacturer's name or trade-mark
- b) Grade/ class designation: like LD, MD, and HD.
- c) Year of manufacture
- d) MCGM
- e) The words SWD or 'Sewer' to denote 'storm water drain' or 'sewer' respectively

3.3.9. Installation of covers & Frame

Installation shall be carried out in accordance with the relevant Code of Practice. Until such Codes of Practice exist, the National Code of Practice or the manufacturer's guide should be used. The cover with frame shall be fixed in M30 Grade of concrete.

3.3.10. The cover shall be air tight and water tight.

3.3.11. The sizes of covers specified shall be taken as the clear internal dimensions of opening.

3.3.12. The weight of various type of manhole covers and frames shall be as per IS 1726, however approximate weight range of the various type of manhole covers and frames are given below:

Table 3.3.1

| Size of clear cover (mm) | Approx. weight in kg for grade | | |
|--------------------------|--------------------------------|---------|----------|
| | MD - 10 | HD - 20 | EHD - 35 |
| 560 dia | | 208 | |
| 1200 x 900 | | 950 | |
| 900 x 450 | | 225 | |
| 900 x 600 | | 270 | |

3.3.13. The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

3.3.14. Locking Devices

Suitable locking arrangements including that with galvanized chain or a lock, or

both shall be provided for the manhole cover fixing with the frame. The cost of locking arrangements will be paid separately.

3.3.15. Inspection and Testing for Covers and frames

Covers & frames shall be subjected to following tests for acceptance:

- a) Visual & Dimensional check as per Clause 6 and 7 of IS 1726
- b) Load test as per Clause 10 of IS 1726

3.3.16. Transporting & handling

- a) The Covers & frames should be preferably transported by road from the factory and stored as per the manufacturer specifications to protect damage.
- b) The Covers & frames shall be transported from the factory to the work sites at places along the alignment of Storm water drain as directed by Engineer and as specified by manufacturer.
- c) Contractor shall be responsible for the safety of covers & frames in transit, loading/unloading. Every care shall be exercised in handling covers & frames to avoid damage.
- d) The covers & frames shall be unloaded on timber skids with steadying ropes for by any other approved means.
- e) Suitable gaps in the covers & frames stacked shall be left at intervals to permit access from one side to the other.
- f) The covers & frames received on site shall be jointly checked for any visible damages shall be pointed out immediately to the Engineer at the site and recorded properly. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost. Any cover & frame which shows sufficient damage to preclude it from being used shall be discarded.

3.3.17. Measurement and payment

Measurement shall be done in number basis with specified clear cover size. All concrete works shall be measured and the cost of the same is included in Supply & fixing of covers & frame and paid under the respective items of work.

The rate shall include the cost of materials and labour involved in all the operation described above except Installation of frames and covers which shall be paid as extra unless specified otherwise in the item.

3.4. PRECAST CONCRETE MANHOLE COVERS AND FRAMES

3.4.1. The precast steel reinforced cement concrete covers and frame shall be manufactured from appropriate grade of concrete for satisfying the design traffic requirement but the grade of concrete not inferior than M30 grade conforming to 456 shall be used.

3.4.2. Materials

- a) Cement: Cement used for the manufacture of pre-cast concrete manhole covers shall be 43 grade Portland cement conforming to IS-8112.
- b) Aggregates: The aggregates used shall be clean and free from deleterious matter and shall conform to the requirements of IS-383. The aggregates shall be well graded and the nominal maximum size of coarse aggregate shall not exceed 20 mm.
- c) Concrete: The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combing etc. The minimum cement content in the concrete shall be 410 kg/m³ with a maximum water cement ratio of 0.45. Concrete weaker than grade M30 (design mix) shall not be used. Compaction of concrete shall be done by machine vibration.
- d) Reinforcement: The reinforcement steel shall conform to IS 1786. Reinforcement shall be clean and free from loose mill scale, loose rust, and mud, oil, grease or any other coating which may reduce or destroy the bond between the concrete and steel. A light film of rust may not be regarded as harmful but steel shall not be visibly pitted by rust.
- e) Fibers Steel: The diameter/equivalent diameter of steel fibers where used, shall not be greater than 0.75 mm. The aspect ratio shall be in the range of 50 to 80. The minimum volume of fibers shall be 0.5 percent of the volume of concrete.
- f) The reinforced concrete manhole cover and frame shall be designed in accordance with the provisions of IS 456. Clear cover to reinforcement shall not be less than 15 mm.

3.4.3. Shapes and Dimensions:

- a) Shape, dimensions and tolerance of precast concrete manhole covers and frames shall conform to IS 12592. Outside dimension of cover at top shall match with corresponding frame so that the maximum clearance at top between the frame and the cover all round the periphery is not more than 5 mm and the top surface of the frame and covers, is in level within a tolerance of +5 mm.
- b) For facility of removing the cover from the frame, suitable taper matching with taper given for the frame shall be provided to the periphery of the cover.

3.4.4. Lifting Device

The minimum diameter of mild steel rod used as lifting device shall be 12 mm for light and medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by hot galvanising or epoxy coating or any other suitable treatment.

3.4.5. Finishing & Coating

- a) To prevent any possible damage from corrosion of steel the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish.
- b) In order to protect the edges of the covers from possible damage at the time of lifting and handling it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2.5 mm thickness around the periphery of the covers.
- c) Exposed surface of mild steel sheet shall be given suitable treatment with anticorrosive paint or coating. To prevent the top outer edge of frame from possible damages, it shall be protected by 25 mm X 3 mm mild steel flat as part of the frame.

3.4.6. Physical Requirements

- a) General: All units shall be sound and free from cracks and other defects which interface with the proper placing of the unit or impair the strength or performance of the units. Minor chipping at the edge/surface resulting from the customary methods of handling during delivery shall not be deemed for

rejecting.

- b) Load Test: The breaking load of individual units when tested in accordance with the method described in IS 12592 shall be not less than the values specified in Table 3.3.1

TABLE 3.3.1

| <i>Grade of Cover</i> | <i>Type</i> | <i>Load in Tonnes</i> | <i>Diameter of Blocks in mm</i> |
|-----------------------|---------------------------------|-----------------------|---------------------------------|
| EHD - 35 | Circular, Square or Rectangular | 35 | 300 |
| HD - 20 | Circular, Square or Rectangular | 20 | 300 |
| MD - 10 | Circular or Rectangular | 10 | 300 |

3.4.7. Installation of Precast Concrete Covers and frames:

The frames of manhole shall be firmly embedded to correct alignment and level in RCC slab or plain concrete as the case may be on the top of masonry which shall be paid as extra unless specified otherwise.

The cover with frame shall be fixed in M30 Grade of concrete.

3.4.8. Transporting & handling

- a) The Covers & frames should be preferably transported by road from the factory and stored as per the manufacturer specifications to protect damage.
- b) The Covers & frames shall be transported from the factory to the work sites at places along the alignment of Storm water drain as directed by Engineer and as specified by manufacturer.
- c) Contractor shall be responsible for the safety of covers & frames in transit, loading/unloading. Every care shall be exercised in handling covers & frames to avoid damage.
- d) The covers & frames shall be unloaded on timber skids with steadying ropes for by any other approved means.
- e) Suitable gaps in the covers & frames stacked shall be left at intervals to permit

access from one side to the other.

- f) The covers & frames received on site shall be jointly checked for any visible damages shall be pointed out immediately to the Engineer at the site and recorded properly. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost. Any cover & frame which shows sufficient damage to preclude it from being used shall be discarded.

3.4.9. Measurements and payment

Measurement shall be done in number basis with specified clear cover size. All concrete works shall be measured and the cost of the same is included in Supply & fixing of covers & frame and paid under the respective items of work.

The rate shall include the cost of materials and labour involved in all the operation described above except Installation of frames and covers which shall be paid as extra unless specified otherwise in the item.

3.5. DUCTILE IRON MANHOLE COVERS AND FRAMES / GRATING WITH FRAME

- 3.5.1. The covers and frame shall be manufactured from appropriate grade of Ductile iron (Spheroid graphite or nodular iron) conforming to IS 1865. However Grade SG500/7 & SG500/7A is recommended as per manufacturer specifications.

- 3.5.2. The micro-structure of ductile iron shall contain minimum 80 percent graphite in the form of V or VI designations as specified in IS7754.

- 3.5.3. The castings shall be sound, clean and free from blow-holes, slag inclusions, distortion, hard spots, sand—fusion ,porous space sand/air holes, cold shuts and all surface and other defects . They shall be well dressed, fettled and shall be straight, regular and true in every respect, Casting shall not be welded or plugged except by agreement between the Engineer in charge & manufacturer as per site requirement.

- 3.5.4. Covers shall have on its operative top a raised chequered design to provide an adequate no-slip grip. The rise of chequers shall be not less than 4 mm.

- 3.5.5. Key holes, keys and lifting devices as per EN 124 shall be provided in the covers to

facilitate their placement in the frames and their operative maintenance.

3.5.6. Opening angle of hinged covers and gratings:

The opening angle of hinged covers or gratings shall be at least 100° to the horizontal however the recommended opening angle shall be 120° to the horizontal.

3.5.7. Bituminous coating for covers and frames

The covers and frames shall be coated with materials having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to temperature of 63°C and shall not be so brittle as to chip off at temperature of 0°C.

3.5.8. Size and shape.

The size & shape of manhole covers & frames shall be as per Table 3.5.1 unless & otherwise specified by the Engineer in charge.

Table 3.5.1

| Size of clear manhole cover (mm) | Approx. weight in kg for grade | | |
|----------------------------------|--------------------------------|------------|-------------|
| | B 125 (MD) | C 250 (HD) | D 400 (EHD) |
| 560 dia | 55 | 80 | 95 |
| 1200 x 900 | 2 nos of 600 x 900 may be used | | |
| 900 x 450 | 75 | 125 | 160 |
| 900 x 600 | 105 | 150 | |

The size & shape of grating & frames shall be as per Table 3.5.2 unless & otherwise specified by the Engineer in charge.

Table 3.5.2

| Size of clear grating (mm) | Approx. weight in kg for grade | | |
|----------------------------|--------------------------------|-----------|-------------|
| | B 125 (MD) | C 250(HD) | D 400 (EHD) |
| 1200 x 600 | 2 nos of 600 x 900 may be used | | |
| 600 x 500 | | 80 | |
| 450 x 450 | | 56 | |

3.5.9. The performance requirement of manhole covers and frames/ grating with frames shall conform to EN 124 .

3.5.10. Frame Seating area

The bearing area shall be designed in such a way that: a) the bearing pressure in relation to the test load shall not exceed 7.5 N/mm²; and it should provides an adequate contribution to stability under working conditions. Minimum 75mm frame seating is recommended.

3.5.11. Slot area as waterway in grating.

The dimension of slots shall be selected considering hydraulic capacity and slots shall be evenly distributed throughout the clear size of grating. The total area of opening shall not be less than 30% of clear size of grating & the same shall be specified by manufacturers.

3.5.12. Marking

All manhole covers and frame shall have cast with the following information marked on them:

- Manufacturer's name or trade-mark
- Grade/ class designation : like B125-MD, C250 -HD, D400 –EHD.
- Year of manufacture

d) MCGM

e) The words SWD or 'Sewer' to denote 'storm water drain' or 'sewer' respectively

3.5.13. Installation of covers & Frame

Installation shall be carried out in accordance with the relevant Code of Practice. Until such Codes of Practice exist, the National Code of Practice or the manufacturer's guide should be used.

3.5.14. The cover with frame shall be fixed in M20 Grade of concrete for normal case however on the roads having heavy axle loads or heavy traffic, The cover with frame shall be fixed in M30 Grade of concrete (for such cases, difference in M30 & M20 cost shall be paid separately.)

3.5.15. The cover shall be air tight and water tight.

3.5.16. The sizes of covers specified shall be taken as the clear internal dimensions of the frame.

3.5.17. The weight of the various types of manhole covers and frames shall be Sufficient to sustain test load as per EN 124 & IS 1726, however approximate weight range of the manhole covers with frames and grating with frame are given in Table 3.5.1 and Table 3.5.2 respectively.

3.5.18. The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

3.5.19. The manhole covers with frame and grating with frame shall conform to EN124.

3.5.20. Inspection and Testing for Covers and frames

Covers & frames shall be subjected to following tests for acceptance:

a) Visual & Dimensional check as per EN 124

b) Load test as per EN 124 and in line comparison with as per Clause 10 of IS 1726 and

c) Mechanical properties test as per EN124 & IS1865.

3.5.21. Transporting & handling

a) The Covers & frames should be preferably transported by road from the factory and stored as per the manufacturer specifications to protect damage.

b) The Covers & frames shall be transported from the factory to the work sites at places along the alignment of Storm water drain as directed by Engineer and as specified by manufacturer.

c) Contractor shall be responsible for the safety of covers & frames in transit, loading/unloading. Every care shall be exercised in handling covers & frames to

avoid damage.

- d) The covers & frames shall be unloaded on timber skids with steadying ropes for by any other approved means.
- e) Suitable gaps in the covers & frames stacked shall be left at intervals to permit access from one side to the other.
- f) The covers & frames received on site shall be jointly checked for any visible damages shall be pointed out immediately to the Engineer at the site and recorded properly. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost. Any cover & frame which shows sufficient damage to preclude it from being used shall be discarded.

3.5.22. Measurement & payment

Measurement shall be done in number basis with specified clear cover size. All concrete works shall be measured and the cost of the same is included in Supply & fixing of covers & frame and paid under the respective items of work.

The rate shall include the cost of materials and labour involved in all the operation described above except Installation of frames and covers which shall be paid as extra unless specified otherwise in the item.

3.6. COMPOSITE RESIN MANHOLE COVERS AND FRAMES / GRATING WITH FRAME

3.6.1. The composite resin covers and frame shall be manufactured from appropriate grade of glass fiber reinforced polyester (GFRP) modified for durability & abrasion resistance using special grade of resin.

3.6.2. Material :

- a) Isophthalic grade of polyester resin reinforcing with glass fibres of appropriate grade & make shall be used for manufacturing of composite resin covers and frame/ grating with frame.
- b) Types of glass fibre used shall be specified by manufacturer's specifications.
- c) Resin: The manufacturer shall use only Isophthalic grade of polyester resin of appropriate grade designed for use with drainage application. Isophthalic grade of polyester resin shall be used for top layer.
- d) The quartz aggregates used as filler in polymer concrete shall meet the

requirements as per manufacturer’s specification.

e) Resin additives, such as curing agents, pigments, dyes, fillers and thixotropic agents, used as required shall not be detrimental to the manholes.

3.6.3. The top surface layer of cover shall be UV resistant & shall have sufficient abrasion resistance to vehicular traffic movement.

3.6.4. The core inside the outer surface layer shall be complete solid & shall be made up of glass fibre & polymer concrete. No pours & hollow space shall be kept in the core layer.

3.6.5. The castings shall be sound, clean and free from porous space, air holes and other defects. They shall be well dressed, fettled and shall be straight, regular and true in every respect,

3.6.6. Covers shall have on its operative top a raised chequered design to provide an adequate no-slip grip as per EN 124.

3.6.7. Key holes, keys and lifting devices as per EN 124 shall be provided in the covers to facilitate their placement in the frames and their operative maintenance.

3.6.8. Colour of Cover & frame

The covers & frames shall be of appropriate colour to suit the site conditions or as specified by the Engineer in charge. Black or grey colour manhole covers with frames are recommended in the carriageway of road.

3.6.9. Locking Devices

Suitable locking arrangements including that with SS chain/Wire Rope or a lock, or both shall be provided for the manhole cover fixing with the frame. The cost of locking arrangements will be paid separately.

3.6.10. size and shape

The size & shape of manhole covers & frames shall be as per Table 3.6.1 unless & otherwise specified by the Engineer in charge.

Table 3.6.1

| Class/ grade | Size of clear manhole cover (mm) |
|--------------|----------------------------------|
|--------------|----------------------------------|

| | | | | |
|-------------|---------|-----------|-----------|------------|
| B125 (MD) | | 900 x 450 | 900 x 600 | 1200 x 900 |
| C 250 (HD) | 560 dia | 900 x 450 | 900 x 600 | 1200 x 900 |
| D 400 (EHD) | 560 dia | 900 x 450 | 900 x 600 | |

The size & shape of grating & frames shall be as per Table 3.6.2 unless & otherwise specified by the Engineer in charge.

Table 3.6.2

| Class/ grade | Size of clear manhole cover (mm) | | |
|--------------|----------------------------------|-----------|------------|
| B125 (MD) | | | |
| C 250 (HD) | 450 x 450 | 600 x 500 | 1200 x 600 |
| D 400 (EHD) | 450 x 450 | 600 x 500 | |

3.6.11. The performance requirement of manhole covers and frames/ grating with frames shall conform to EN 124 .

3.6.12. The weight of cover or grating should be sufficient to withstand the floatation or uplift due to water inside manhole or chamber.

3.6.13. Frame Seating area

The bearing area shall be designed in such a way that: a) the bearing pressure in relation to the test load shall not exceed 7.5 N/mm²; and it should provides an adequate contribution to stability under working conditions. Minimum 75mm frame seating is recommended.

3.6.14. Slot area as waterway in grating

The dimension of slots shall be selected considering hydraulic capacity and slots shall be evenly distributed throughout the clear size of grating. The total waterway

area (area of opening) shall not be less than 30% of clear size of grating & the same shall be specified by manufacturers.

3.6.15. Marking

All manhole covers and frame shall have cast with the following information marked on them:

- a) Manufacturer's name or trade-mark
- b) Grade/ class designation: like B125-MD, C250 -HD, D400 –EHD.
- c) Year of manufacture
- d) MCGM
- e) The words SWD or 'Sewer' to denote 'storm water drain' or 'sewer' respectively

3.6.16. Installation of covers & Frame

Installation shall be carried out in accordance with the relevant Code of Practice. Until such Codes of Practice exist, the National Code of Practice or the manufacturer's guide should be used.

The cover with frame shall be fixed in M20 Grade of concrete for normal case however on the roads having heavy axle loads or heavy traffic, The cover with frame shall be fixed in M30 Grade of concrete (for such cases, difference in M30 & M20 cost shall be paid separately.)

3.6.17. The cover shall be air tight and water tight.

3.6.18. The sizes of covers specified shall be taken as the clear internal dimensions of the frame.

3.6.19. The weight of the various types of manhole covers and frames shall be Sufficient to sustain test load as per EN 124 & IS 1726, however approximate weight range of the manhole covers with frames and grating with frame are given in Table 3.5.1 and Table 3.5.2 respectively.

3.6.20. The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

3.6.21. The manhole covers with frame and grating with frame shall conform to EN124.

3.6.22. Inspection and Testing for Covers and frames

Covers & frames shall be subjected to following tests for acceptance:

- a) Visual & Dimensional check as per EN 124
- b) Load test as per EN 124 and in line comparison with as per Clause 10 of IS 1726 and
- c) Mechanical properties test as per EN 124.

3.6.23. Transporting & handling

- a) The Covers & frames should be preferably transported by road from the factory and stored as per the manufacturer specifications to protect damage.
- b) The Covers & frames shall be transported from the factory to the work sites at places along the alignment of Storm water drain as directed by Engineer and as specified by manufacturer.
- c) Contractor shall be responsible for the safety of covers & frames in transit, loading/unloading. Every care shall be exercised in handling covers & frames to avoid damage.
- d) The covers & frames shall be unloaded on timber skids with steadying ropes for by any other approved means.
- e) Suitable gaps in the covers & frames stacked shall be left at intervals to permit access from one side to the other.
- f) The covers & frames received on site shall be jointly checked for any visible damages shall be pointed out immediately to the Engineer at the site and recorded properly. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost. Any cover & frame which shows sufficient damage to preclude it from being used shall be discarded.

3.6.24. Measurement and payment

Measurement shall be done in number basis with specified clear cover size. All concrete works shall be measured and the cost of the same is included in Supply & fixing of covers & frame and paid under the respective items of work.

The rate shall include the cost of materials and labour involved in all the operation described above except Installation of frames and covers which shall be paid as extra unless specified otherwise in the item.

END.

1.0 **SCOPE**

This specification covers the general requirements of repairs and rehabilitation works related to manholes/chambers, storm water drains, lining of drains, grouting and shotcreting of drains considerations for manholes and their construction and safety requirements.

2.0 **LOCAL AND STRUCTURAL REPAIRS**

2.1. **PROVISION OF NEW PERMANENT ACCESS SHAFTS TO FACILITATE THE REHABILITATION WORKS.**

A conceptual design for new permanent access shafts is provided as per the design documents to provide access into the drain to facilitate the rehabilitation works and for future maintenance of the drain. The location / size of the shaft shall be determined by the contractor and be approved by the Engineer in advance. In sitting the shafts, the contractor shall give due consideration to the establishment of suitable working, storage and delivery areas, traffic management requirements and the avoidance of damage to utilities mains and apparatus as well as minimizing disruption and environmental impacts to adjacent business and residences. The Contractor shall be responsible for liaising with all persons affected by the shaft works including Utility Bodies, the Highway Authority and the Traffic police. Due to the requirement to reduce traffic disruption to minimum during the rehabilitation work, it may be a requirement to place the new access shafts off the line of the existing drain and away from the main road and to provide horizontal access into the drain from these shafts. As far as possible the existing manhole shafts for access or egress by labour, plant and materials should not be used.

2.2. **LOCAL AND STRUCTURAL REPAIRS PRIOR TO LINING .**

Prior to surface preparation the lining work, the Engineer- In -Charge shall instruct the contractor as to which areas of the drains are to be locally repaired, and shall specify the extent of the treatment necessary and the type of repairs to be carried out

In general, the local repairs will comprise the removal of localized areas of the inner course of loose, bulging or otherwise defective masonry or brickwork and their replacement in similar materials built in 3:1 cement mortar, or in Grade M30 mass

concrete placed using curved or straight forms as appropriate to the circumstances. Similarly where the collapse has occurred, all loose material, debris etc. shall be removed from around the opening, rough shutters following the original alignment of the internal surface of the drain shall be put in place and the lost material replaced with Grade M30 concrete which shall extend to a minimum depth of 400mm above and the original profile of the outer surface of the drain and for a minimum of 400mm beyond the opening. For all situations, the contractor shall ensure that the repair is adequately toothed or keyed into the existing structure so as to provide a stable repair that will not dislodge from the structure under its self weight or during lining operations.

2.3. Damage Occurring during Preparation

Should any damage to the existing drain be caused by the preparation, then the contractor shall repair this damage where in the opinion of the Engineer such damage will negatively affect the results of the rehabilitation. In this case, the contractor shall obtain approval from the Engineer for the method to repair the damages prior to other repairs taken up.

2.4. MANHOLES

2.4.1. Repairs of manholes

All corroded and foreign material shall be removed from the manholes/ chambers walls and benching to reveal sound brick, concrete and mortar surfaces. Loose and protruding brick, concrete and mortar shall be removed and safely disposed of. All active leaks shall be stopped with mortar, cementaceous or polymer grout or chemical sealant, Voids and other missing bricks shall be replaced with new bricks, concrete and mortar shall be plastered to a thickness of 20mm. Where thin layers of concrete and mortar are to be applied, the surface shall be prepared with an approved polymer bonding agent before plastering. Mortar shall consist of a minimum, one part sulphate resisting cement to two parts of clean fine sand, adding only sufficient water to make a stiff mix for trowel application.

All manhole steps shall be replaced by plastic encapsulated foot rests bonded into drilled holes with protective mortar. No debris from reconstruction shall enter the drain and removed/ safely disposed off.

2.4.2. Raising/Lowering of Manholes

As per site conditions, some of the existing manholes may require raising to match the surrounding finished road/ground level as directed by Engineer. The necessary brickwork and plastering of the raised surfaces is required to be carried out as per the standard details. The coping of M30 grade to be done on the brickwork. The existing frames and covers are to be carefully removed and refixed as per the

standard procedure and as per the surrounding finishing level requirement. Similarly the Manholes/chambers to be lowered to the required grade and level with the necessary breakages of masonry and plaster . The same shall be disposed off as directed by Engineer .The required Levels to be matched to the surrounding finished road/ground level as directed by Engineer.

2.5. REPLACEMENT OF SECTIONS OF DRAIN.

During the course of works it may be decided that manholes and certain portions of the drain are beyond economic repair and require demolition and reconstruction .should this be necessary the manhole and drain is to be reconstructed to the same internal profile on the same alignment and level where possible. The contractor should prepare full designs, including structural details, of the manholes/ manhole access shafts/ new section and obtain the approval of the Engineer prior to commencement of construction works. it is envisaged that the construction will be carried out in reinforced concrete

On completion of the reconstructed section(s) of drains and manholes they will be lined with a protective coating as in continuation of adjacent sections of the existing drain to provide a continuous uninterrupted coat.

The price quoted for reconstruction of the manhole and drain should include all necessary excavation, breaking out of the existing structure, construction, construction of new openings at the location of existing opening, connection of all incoming pipes and dealing with the flow there from during construction, tying into the existing structure, clearing all debris, backfilling and reinstatement of the ground to its original condition.

2.6. DRILLING AND PRESSURE GROUTING ARCH ABUTMENT ZONES

Drilling and pressure grouting of arch abutment zones shall be carried out from within the drain over the full length of the outer walls irrespective of the type of lining to be installed in any section.

The contractor shall discuss the sequence of grouting, location of grouting holes, grouting pressures, details of grout mix and other details with the Engineer and incorporate the agreed details in his submission for the Engineers approval.

Drilling shall use 50mm diameter holes drilled through the masonry walls and penetrating to the mid point of the 1m wide zone to be grouted. The spacing of the holes, vertically and horizontally shall be sufficiently close to guarantee penetration of the grout to all loose or voided areas in the zone but shall be not greater than

750mm. Grouting at any hole shall continue at each hole until refusal or until grout shows at the nearest ungrouted hole.

Grout shall comprise a mixture of Portland cement and portable water. The water /cement ratio shall be in the range of 0.35-0.45 as appropriate to the circumstances. The Engineer may allow the use of plasticizers or non-shrink agents in the grout mix or other additives except those containing calcium chloride.

Apparatus for mixing and placing grout shall be of a type approved by the Engineer and shall be capable of effectively mixing and stirring the grout to a thixotropic mix and then pumping it under pressure in a continuous uninterrupted flow. After grouting is completed, pressure in the work shall be maintained by means of stopcocks or other suitable device until the grout has set sufficiently. After the grout has set, the stopcocks and grouting tubes shall be removed and the grout holes completely filled.

2.7. Drilling and Pressure Grouting Masonry walls.

Drilling and pressure grouting of the drain outer and central masonry walls shall be carried out from within the drain over the full length of the walls.

The contractor shall discuss the sequence of grouting, location of grouting holes, grouting pressures, details of grout mix and additives and other details with the Engineer and incorporate the agreed details in his submission for the Engineer's approval.

Drilling shall use 50mm diameter holes drilled to three quarter depth of the masonry walls. The spacing of the holes vertically and horizontally shall be sufficiently close to guarantee penetration of the grout to all loose or voided areas in the walls but shall be not greater than 750mm. Grouting at any hole shall continue at each hole until refusal or until grout shows at the nearest ungrouted hole. The grouting pressure shall be regulated and controlled so as to not cause excessive pressure build up in the wall that might cause bulging of the wall or collapse of the wall faces.

Grout shall comprise a mixture of Portland cement and portable water. The water / cement ratio shall be in the range of 0.35-0.45 as appropriate to the circumstances. The Engineer may allow the use of plasticisers or non shrink agents in the grout mix or other additives except those containing calcium chloride.

Apparatus for mixing and placing grout shall be of a type approved by the Engineer and shall be capable of effectively mixing and stirring the grout to a thixotropic mix and then pumping it under pressure in a continuous uninterrupted flow. After

grouting is completed, pressure in the work shall be maintained by means of stopcocks or other suitable devices until the grout has set sufficiently. After the grout has set, the stopcocks and grouting tubes shall be removed and the grout holes completely filled.

3.0 LINING DESIGN AND INSTALLATION

3.1. SCOPE AND INTENT

The specification details, minimum design and performance requirements that must be met by the lining system. The intent of rehabilitating the existing drains by lining is to:

- a) Restore or increase the structural capacity of the drains and enhance its service life by not less than 50-years;
- b) Protect the internal surface of drain from deterioration;
- c) Not reduce the capacity of the drain below that required in the drainage master plan (information with MCGM):
- d) Prevent infiltration of ground water and exfiltration of storm water ;and,
- e) Restore grad as far as possible.

3.2. GENERAL DESIGN REQUIREMENTS

3.2.1. General

The structural condition of the existing drains shall be identified by manual and CCTV survey and assessed in accordance with the WRC SRM 4th ED and the Manual of sewer condition classification (MSCC) in the progress of the contract. Where the structural condition is considered inadequate in a drainage line, the lining shall be designed and installed from the nearest upstream manhole to the nearest downstream manhole, and as approved by the Engineer.

The liners shall be designed to resist hydrostatic load or all loads (Hydrostatic soil and surface surcharge loads) as determined by the condition assessment and approved by the Engineer in accordance with the WRC SRM Vol II.

3.2.2. Design Life

The design life of the installed lining system shall be not less than 50-years under live conditions. The Contractor shall produce documentary evidence to substantiate the 50-years design life of the system on which his e-tender is based.

3.2.3. Design Loads

Design loads shall comprise the maximum loading produced from the combination of earth pressures, hydrostatic loads and traffic loads.

Vertical earth pressures shall comprise the full height of soil above the structure without reduction for soil arching effects. Maximum hydrostatic pressure from groundwater shall be determined assuming the water table is located at ground surface level.

Traffic loads shall be calculated in accordance with Indian Road Congress AA Class Loading standard or similar approved code. Loads shall vary depending on road usage as follows:

- a) TYPE A: Main Road. Multiple adjacent lanes for standard T44 or standard W7 wheel loads.
- b) TYPE B: Light Road. Single lane of standard T44 or standard W7 wheel loads.
- c) TYPE C: Field Load. 60% of light road loading.
- d) The type of traffic loads applicable to each section of the drain shall be agreed in advance of design with the Engineer.

3.2.4. Design responsibility

The Contractor shall be responsible for the suitability and correctness of the chosen liner design calculations necessary to substantiate that the lining system will be suitable in the long term for loads and conditions experienced by the lining.

The design requirements set down in this clause shall be considered as minimum requirements. The contractors may adopt more conservative assumptions or design methods should they consider it necessary to accept full design responsibility.

Review of the Contractor's design calculations shall not be construed as acceptances of the calculations. Responsibility of the design even approved by the Engineer based on the field parameters submitted by the contractor: the same shall remain with the contractor only.

3.3. INSTALLATION OF TYPE I LININGS-SHOTCRETE AND IN-SITU CONCRETE

Type I Lining are as defined in the sewerage Rehabilitation manual, Vol II Edition 2001/latest edition, published by the UK Water Research Centre (WRC). The method of construction shall use either pumped In-situ Concrete placed behind travelling formwork (Method A), or reinforced shotcrete applied by pneumatic spraying (Method B). The choice of method of application is to be selected by the

Contractor and provision is made in the pricing Schedule for pricing either of these alternative methods. In case of Method, the concrete used shall be from approved Ready Mix Concrete plants of MCGM.

In –situ Reinforced Concrete shall comply in all respects with section 4 Concrete and Allied Works, Section IIC, General Specification (Civil), and shall be Class M40 using Portland-Pozzolana Cement complying with IS:1489 Part 1. The mix shall be designed to a consistency suitable for pumping over distance and to ensure complete filling of the formwork and penetration around the reinforcing bars without voids. The Engineer may allow the use of plasticisers or non shrink agents in the concrete mix or other additives except those containing calcium chloride.

Formwork shall be designed to produce a Class F3 finish to the internal surfaces of the lining as defined in Sections 5.3 and 4.22 of the General Specification (Civil), and shall comprise collapsible or telescopic travelling forms of robust design adequate to sustain all dead and live loads including pumping pressures. The forms shall be capable of sustaining external vibration for concrete compaction and shall be provided with stop ends and an adequate number of closable pump hose connection and inspection ports to ensure concrete can reach all sections of the lining under pressure.

Shotcrete and shotcreting shall be carried out in accordance with the following American Concrete Institute (ACI) and ASTM International standards which form a part of this specification. Shotcrete shall be applied as a “wet mix” and shall provide a minimum compressive strength of 40 n/mm² at 28-days. Cement shall be sulphate resisting Portland cement complying with IS:12330. Maximum aggregate size shall be 10 mm.

- a) ACI 506R-05, Guide to Shotcrete, 2005
- b) ACI 506.1R-98, State –of-the-Art Report on Fibre Reinforced Shotcrete, 1998
- c) ACI 506.2-95, Specification for shotcrete, 1995
- d) ACI 506.4R-94, Guide fo the Evaluation of shotcrete, 1994
- e) ACI.3R-91, Guide to Certification of shotcrete Nozzlemen, 1991
- f) ACI CCS4, Shotcrete for the craftsman ,2000
- g) ACI C660, Shotcrete Nozzleman Craftsman workbook, 2002
- h) ASTM C1604/C1604M-05, Standard test Method for obtaining and Testing Drilled Cores in Shotcrete, 2003
- i) ASTM C1141-01, Standard Specification for Admixtures in Shotcrete, 2001
- j) ASTM C1385-98, Standard Practice for sampling Materials in Shotcrete. 1998

All internal faces of the shotcrete lining shall be steel trowelled under firm hand

pressure following installation to provide an appropriate finish to receive the high build protective chemically resistant final coating.

Secure and robust arrangement for the fixing of reinforcing bar to the linings will be required for both alternative methods of forming the Type I lining. This shall be achieved by drilling into the brick arches and masonry walls and fixing spacer / hanger bars shall be anchored in the holes by an protective fill or as expanding anchors or other approved method of fixing.

The contractor shall be responsible for determining the size and spacing of the fixing to accurately maintain the specified concrete cover to the lining reinforcement as part of his structural design of the works. The Contractors design shall make safe allowance for the pull out forces from the self –weight of the reinforcing mat and for all dynamic loads from In-situ Concrete placement or shotcrete application.

It is a requirement that the contractor demonstrates the competence of his proposed shotcrete nozzle operators by providing documentary evidence of their competence and experience on similar works or by satisfactory completion of a pre- construction test panel of a 3m long section of a single drain barrel.

Notwithstanding the above requirement, the lining thicknesses shall not be less than 100mm and shall not exceed 150mm. Preference will be given to the lesser thickness, and all lining thicknesses shall be as approved by the Engineer. Lining shall be applicable to all internal faces in the drain including bottom floor.

3.4. INSTALLATION OF TYPE II LININGS-IN-SITU CONCRETE AND SHOTCRETE

The lining works to the drain shall comprise Type II Linings as defined in the sewerage Rehabilitation Manual, Vol II, Edition 2001/latest edition, published by the UK water Research Centre (WRC).

The method of construction if Type II lining shall use provision and placing concrete, provision and fixing multiple layers of galvanised steel mesh reinforcement and provision , drilling and fixing all spacers/ hangers into the brick arch and walls, and for steel trowelling all internal surfaces to a Class U3 finish. For the floor slab, the method of construction shall use providing and placing in position controlled cement concrete of grade M40 in walls and deck slab above or below ground level at any height/ depth by using Ordinary Portland Cement and by using Ready Mixed Concrete including Transportation anywhere in Mumbai. The concrete used shall be from approved Ready Mixed Concrete Plants of MCGM. (List of approved concrete ready mix plant can be collected from the MCGM Office of Deputy Chief Engineer (Storm Water Drain), Planning Cell, Engineering Services

and projects , Mumbai)

In situ reinforced concrete shall comply in all respects with Section 4 Concrete and Allied Works, Section IIC, Civil Specification, and shall be class M40 using Portland –Pozzolana Cement complying with IS:1489 Part 1. The mix shall be designed to a consistency suitable for pumping over distance and to ensure complete filling of the formwork and penetration around the reinforcing bars without voids. The Engineer-in-Charge may allow the use of plasticisers or non shrink agents in the concrete mix or other additives except those containing calcium chloride.

Formwork shall be designed to produce a class U3 finish to the internal surfaces of the lining as defined in sections 5.3 and 4.22 of the civil specification, and shall comprise collapsible or telescopic travelling forms of robust design adequate to sustain all dead and live loads including pumping pressures. The forms shall be capable of sustaining external vibration for concrete compaction and shall be provided with stop ends and an adequate number of closable pump hose connection and inspection ports to ensure concrete can reach all sections of the lining under pressure.

Shotcrete and shotcreting shall be carried out in accordance with the following American Concrete Institute(ACI) and ASTM International standards which form a part of this specification. Shotcrete shall be applied as a wet mix and shall provide a minimum compressive strength of 40 N/mm² at 28 days. Cement shall be sulphate resisting Portland cement complying with IS:12330. Maximum aggregate size shall be 10mm.

- a) ACI 506R-05, Guide to shotcrete, 2005
- b) ACI 506.1R-98, State –of-the-Art Report on Fibre Reinforced Shotcrete, 1998
- c) ACI 506.2-95, Specification for shotcrete, 1995
- d) ACI 506.4R-94, Guide for the Evaluation of shotcrete, 1994
- e) ACI.3R-91, Guide to certification of shotcrete Nozzelmen, 1991
- f) ACI CCS4, Shotcrete for the craftsman, 2000
- g) ACI C660, Shotcrete Nozzelman Craftsman Workbook, 2002
- h) ASTM C1604/C1604M-05, Standard Test Method for obtaining and Testing drilled Cores in Shotcrete, 2003
- i) ASTM C1141-01, Standard specification for Admixtures in shotcrete, 2001
- j) ASTM C1385-98, Standard Practice for Sampling Materials in shotcrete. 1998

All internal faces of the shotcrete lining shall be steel trowelled under firm hand pressure following installation to provide an appropriate finish to receive the high build protective chemically resistant final coating.

Steel reinforcement shall be zinc coated hexagonal steel wire netting to British Standard BS 1485 or equivalent Indian Standard. The required cross sectional area of steel reinforcement to meet the structural design requirements may be provided in multiple nested layers provided laps between individual sheets within the layer are not less than 100mm on both the longitudinal and circle joints and that laps do not consider. The steel reinforcing mats shall be fixed to the drains using galvanized or non-metallic fixing drilled into the existing structure at close centers to ensure the specified cover is met and the reinforcement is not dislodged during mortar spraying operations. Spacer shall be inserted where necessary to ensure the specified minimum cover is maintained to both the inner and outer surfaces of the lining. Spacers shall be in non-metallic material of not less than 20mm diameter and shall be securely fixed to the reinforcing mesh. Minimum cover shall be 20mm to both the inside and outside faces of the lining.

The Contractor's design shall make safe allowance for the pull out forces from the self-weight of the reinforcing mat and for all dynamic loads from shotcrete application.

It is a requirement that the contractor demonstrates the competence of his proposed shotcrete nozzle operators by providing documentary evidence of their competence and experience on similar works or by satisfactory completion of a pre construction test panel of a 3m long section of a single drain barrel.

Notwithstanding the above requirement, the lining thicknesses shall not be less than 50 mm and shall not exceed 100mm. Preference will be given to the lesser thickness, and all lining thicknesses shall be as approved by the Engineer. Lining shall be applicable to all internal faces in the drain including bottom floor.

3.5. PROTECTIVE COATING TO LININGS

High build, protective coating is to be applied by spraying to the internal faces of the lining to the drain arches, walls and floor to provide chemical resistance to acid attack by hydrogen sulphide, sea water with tidal effect, other chemicals as also it should be abrasion resistant to the suspended material in the water flowing in the drain and to the comprehensive maintenance and de-silting Operation. The performance requirement of protective coating shall be as follows:

- a) The protective coating shall be non corrosive with untreated sewage, particularly resistant to H₂S attack, sea water, tidal effect, alternate drying and wetting.
- b) High build type with feasibility to build thickness upto 6mm and more.

- c) When applied can stand on vertical surface without sag.
- d) Will withstand abrasive forces that are likely to be encountered, including scouring by grit and rubble travelling at high velocities during flood conditions and the action of silt and debris removing machineries and tools and also dragging buckets etc. During desilting processes:
- e) Can be applied with confidence to wet surfaces with an effective bond that will last over the brick, masonry, concrete or cement plaster surfaces to which it is applied:
- f) Shall provide a smooth surface finish.
- g) The composition of the protective coating shall be stable over minimum 50 years period.
- h) It shall be possible to safely apply the product in a confined underground space like storm water drain without imminent possibilities of fire, explosion, release of poisonous gas and release of heat.
- i) The product shall not contaminate ground water.
- j) The product shall be spray applied.

The thickness of the protective coating shall be as recommended by the manufacturer of the protective coating but shall not be less than 6mm to the bottom floor and to the vertical masonry/RCC walls up to 0.9m from invert of the drain and the thickness of protective coating shall be not less than 3mm to the rest of the internal faces of the drain including internal faces of access shafts and other similar openings to the drain. Thickness significantly reducing the cross sectional area of the drain shall not be accepted. Suggested products for protective coating are:

- i) "Ultracoat" manufactured by Warren Environmental Inc. (www.warrenenviro.com)
- ii) Nukote XT Polyurea by Nukote Coating Systems (www.ncs-intl.net)
- iii) MC-RIM by MC-Bauchemie, Germany (www.mc-bauchemie.com)
- iv) Cipy Polyurehanes Pvt. Ltd. (www.cippolyurethane.com)
- v) Tri- Sewcoat System by Totale Refractories.

It shall be the responsibility of the bidder to ensure that the product selected by him from above suggested products for protective coating shall meet all the performance requirements and specifications included in this document.

The preparation of the lining surfaces by water or sand blasting prior to the application of the coating shall be to the manufacturers requirements.

Coating to the linings shall not take place until the linings have reached at least 28-days age.

Offers of Bidder/s not complying with the above requirements are liable to be rejected.

4.0 SHOTCRETING

This specification defines the general requirements of materials mixing, placing curing, constructional and other performance requirements for strengthening, rehabilitating of concrete structures.. Any other special requirement shown or noted on the drawings or as directed by the Engineer-in-Charge shall govern over the provision of this specification.

4.1. TERMINOLOGY & DEFINATION

Shotcrete-Mortar or concrete conveyed through a hose and projected at high velocity on to a surface also known as air- blown mortar,also pneumatically applied mortar or concrete, sprayed mortar and gunned concrete.

4.1.1. Dry-Mix-Shotcrete- Pneumatically conveyed shotcrete in which most of the mixing water is added at the nozzle.

4.1.2. Gunit (Trade Name) – Method of applying dry-mix-shotcrete.

4.1.3. Wet-Mix Shotcrete- Shotcrete wherein all ingredients, including mixing water , are mixed in the Equipment before introduction into the delivery house; it may be pneumatically conveyed or moved by displacement.

4.2. MATERIALS

All materials to be used for shotcreting shall conform to the requirements of respective IS codes. Samples and test results for all the materials shall be submitted to the Engineer-in-Charge and got approved by him in writing before execution of work. The source of materials shall not be changed during the course of construction without obtaining the approval from Engineer-in-Charge.

Cement- The cement used shall be any of the following, with the prior approval of the Engineer-in-charge:

- a) Ordinary or low heat Portland cement confirming to IS:269-1976*.
- b) Rapid hardening Portland cement confirming to IS:8041-1978.
- c) Portland slag cement confirming to IS: 455-1976.
- d) Portland Pozzolana cement confirming to IS: 1489-1976.
- e) High strength ordinary Portland cement confirming to IS:8112-1976
- f) Hydrophobic cement confirming to IS 8043-1978

4.2.2. Aggregates

Sand for shotcrete shall comply with the requirements given in IS: 383-1970. Sand failing to satisfy this grading may, however, be used if preconstruction testing (Jee 6) establishes that it gives good results. Further sand for finish or flash coats may be finer than the above grading. However, the use of finer sands will generally result in greater drying shrinkage, and coarse sands, in more rebound.

Coarse Aggregate- Coarse aggregates when used shall comply with the requirements of IS: 383-1970. It shall, generally conform to one of the gradings given in Table 1. Maximum size of aggregate shall be 10mm.

| TABLE GRADING OF COARSE AGGREGATES | | | |
|------------------------------------|---|--------|--------|
| IS SIEVE DESIGNATION | PERCENTAGE BY MASS PASSING FOR AGGREGATE OF NOMINAL MAXIMUM SIZE | | |
| | 10mm | 12.5mm | 20mm |
| mm | | | |
| (1) | (2) | (3) | (4) |
| 25 | ----- | ----- | 100 |
| 20 | ----- | 100 | 90-100 |
| 12.5 | 100 | 90-100 | ----- |
| 10 | 85-100 | 40-70 | 20-55 |
| 4.75 | 10-30 | 0-15 | 0-10 |
| 2.36 | 0-10 | 0-5 | 0-5 |
| 1.18 | 0-5 | ----- | ----- |

All oversize pieces shall be rejected by screening, since they are likely to cause plugging of the hose.

4.2.3. Reinforcement

Reinforcing bars if used shall confirm to IS: 432(Part I)-1966 or IS: 1139-196611 or IS 1786-1966 .Welded wire fabric confirming to IS: 1566-1967. also may be used.

4.3. SHOTCRETING PROCESS

The two basic shotcreting processes are:

- a) Dry mix process, and
- b) Wet mix process.

4.3.2. Dry Mix Process

In this process. a mixture of cement and moist sand is conveyed through the delivery hose to a nozzle where most of the mixing water is added under pressure.

This process consist of the following steps:

- a) The Cement and moist sand are thoroughly mixed;
- b) The Cement-sand mixture is fed into a special mechanical feeder or gun referred to in this standard as delivery equipment
- c) The mixture is forced into the delivery hose by a feed wheel or distributor;
- d) The mixed material is carried in suspension by compressed air through the delivery hose to a nozzle, which is filled inside with a perforated manifold through which water is introduced under pressure and intimately mixed with the other ingredients ; and
- e) The mortar is jetted from the nozzle at high velocity on to the surface to be shotcreted.

4.3.3. Wet Mix Process

In this process, all the ingredients including water are mixed before they enter the delivery hose. It consists of the following steps:

- a) All the ingredients (including mixing water) are thoroughly mixed ;
- b) The mortar or concrete is introduced into the chamber of the delivery equipment.
- c) The mixture is forced into the delivery hose and conveyed by compressed air or other means to a nozzle:
- d) Additional air is injected at the nozzle to increase the velocity and improve the shooting pattern; and
- e) The mortar or concrete is jetted from the Nozzle at high velocity on to the surface to be shotcreterd.

4.3.4. Shotcrete suitable for normal construction requirements may be produced by either process. However, difference in cost of equipment, maintenance and operational

features may make one or the other method more attractive for a particular application.

4.4. PROPERTIES OF SHOTCRETE

4.4.1. Properly applied shotcrete is a structurally adequate and durable material capable of excellent bond with concrete, masonry, steel and other materials. However these favorable properties are contingent on proper planning and supervision, and on the skill continuous attention by the operating staff.

4.4.2. The water cement ratio for shotcrete in place normally falls within the range of 0.35 to 0.50 by mass which is somewhat lower than for most conventional concrete mixes. In general the physical properties of sound concrete in place are comparable to those of conventional mortar or concrete of the same composition. Most reported values for 28-day strength are in the range of 20 to 50N/mm². It is recommended that strength higher than 25N/mm² be specified only for the most carefully executed shotcrete jobs.

4.4.3. The drying shrinkage of shotcrete depend somewhat on the mix proportions used, but generally falls within the range of 0.06 to 0.10 percent. This is rather higher than for most low- slump conventional concrete, which is generally placed in heavier sections using larger aggregate and leaner mixes.it will tend to give more shrinkage, cracking, and may require a closer joint spacing. The durability of shotcrete in laboratory tests and under field exposure has generally been good.

4.4.4. Shotcrete offers advantages over conventional concrete in a variety of new construction and repair work. It is frequently more economical because of the lesser forming requirements, and because it requires only a small, portable plant for manufacture and placement.

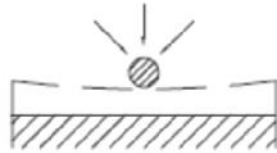
4.5. PRECONSTRUCTION TESTING

The mix proportions, grading and quality of aggregate, amount and spacing of reinforcing steel, position of the work, design and condition of delivery equipment, and the quality of workmanship all affect the quality of shotcrete in place. A laboratory investigation shall, therefore, be carried out prior to the commencement of the work in order to check the operation of the equipment and skill of the operating staff, and also to verify that the specified quality of shotcrete may be expected in the structure. The procedure for preconstruction testing shall be as recommended in 4.5.1 to 4.5.6

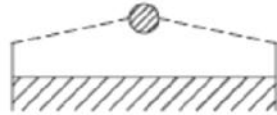
4.5.1. Test panels simulating actual job conditions shall be fabricated by the operating staff, using the equipment, materials and mix proportions proposed for the job.

- 4.5.2. For the dry mix process, the amount of water added at the nozzle is adjusted so that the in-place appears to be adequately compacted and neither sags nor shows excessive rebound. Where justified by the size and importance of the job or lack of previous experience with the materials, it may be advisable to test two or three mixes, generally within the range of 1 part of cement to 3 to 4 ½ parts of sand, before deciding on the final mix proportions.
- 4.5.3. The procedure for the wet mix process is similar to the dry mix process except that the entire mix is premixed to give a work-ability judged to be appropriate for the work, before it is introduced into the chamber of delivery equipment. Test on more than one mix design are usually recommended where it is desired to include coarse aggregate in the mix. Normally 20 to 40 percent of coarse aggregate is first tried, with subsequent mixes adjusted to reflect the result of the first trial.
- 4.5.4. The panels are fabricated by gunning on to a back form of plywood. A separate panel shall be fabricated for each mix design being considered, and also for each gunning position to be encountered in the structure, that is slab, vertical and overhead sections. At least part of the panel shall contain the same reinforcement as the structure, to show whether sound shotcrete is obtained behind the reinforcing rods. The panel shall be large enough to obtain all the test specimens needed, also to indicate what quality and uniformity may be expected in the structure. Generally the size of panel shall be not less than 75x75 cm. The thickness shall be the same as in the structure except that it shall normally be not less than 7.5cm.
- 4.5.5. Cubes or cores shall be taken from the panels for testing. The cores shall have a minimum diameter of 7.5cm and a length-diameter ratio of atleast 1, if possible. The specimens shall be tested in compression at the age of 7 or 28 days or both.
- 4.5.6. The cut surfaces of the specimens shall be carefully examined and additional surfaces shall be exposed by sawing or breaking the panel when it is considered necessary to check the soundness and uniformity of the material. All cut and broken surfaces shall be dense and free from laminations and sand pockets.

4.6. APPLICATION OF SHOTCRETE



GUNITE FORCED BEHIND BAR BY HIGH VELOCITY AND VARIATION OF DIRECTION



BACK OF BAR FULLY ENCASED

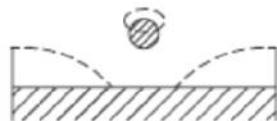


FACE OF BAR STILL FREE OF BUILD-UP

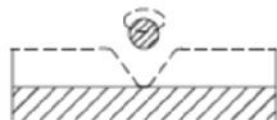


PERFECT ENCASEMENT

PERFECT ENCASEMENT



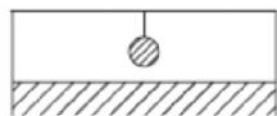
SOFT UNIDIRECTIONAL IMPACT CAUSED BUILD-UP ON BAR



HEAVY BUILD-UP



SAND POCKET FORMING



SHRINKAGE CRACK FORMS AT WEAKEND SECTION

INCORRECT NOZZLE OPERATION

THE EFFECT OF CORRECT AND INCORRECT NOZZLE OPERATION IN ENCAING REINFORCING BARS WITH SHOTCRETE

4.6.1. Alignment Control- Adequate ground wires shall be installed to establish thickness and surface planes of the shotcrete build-up. Both horizontal and vertical ground

wires shall be installed at corners and offsets not clearly fixed by the formwork, for example, at exterior corners of walls, column or beam corners and other locations. They may also be used as screed guide. Ground wires shall be tight and true to line, and placed in such a manner that they may be further tightened.

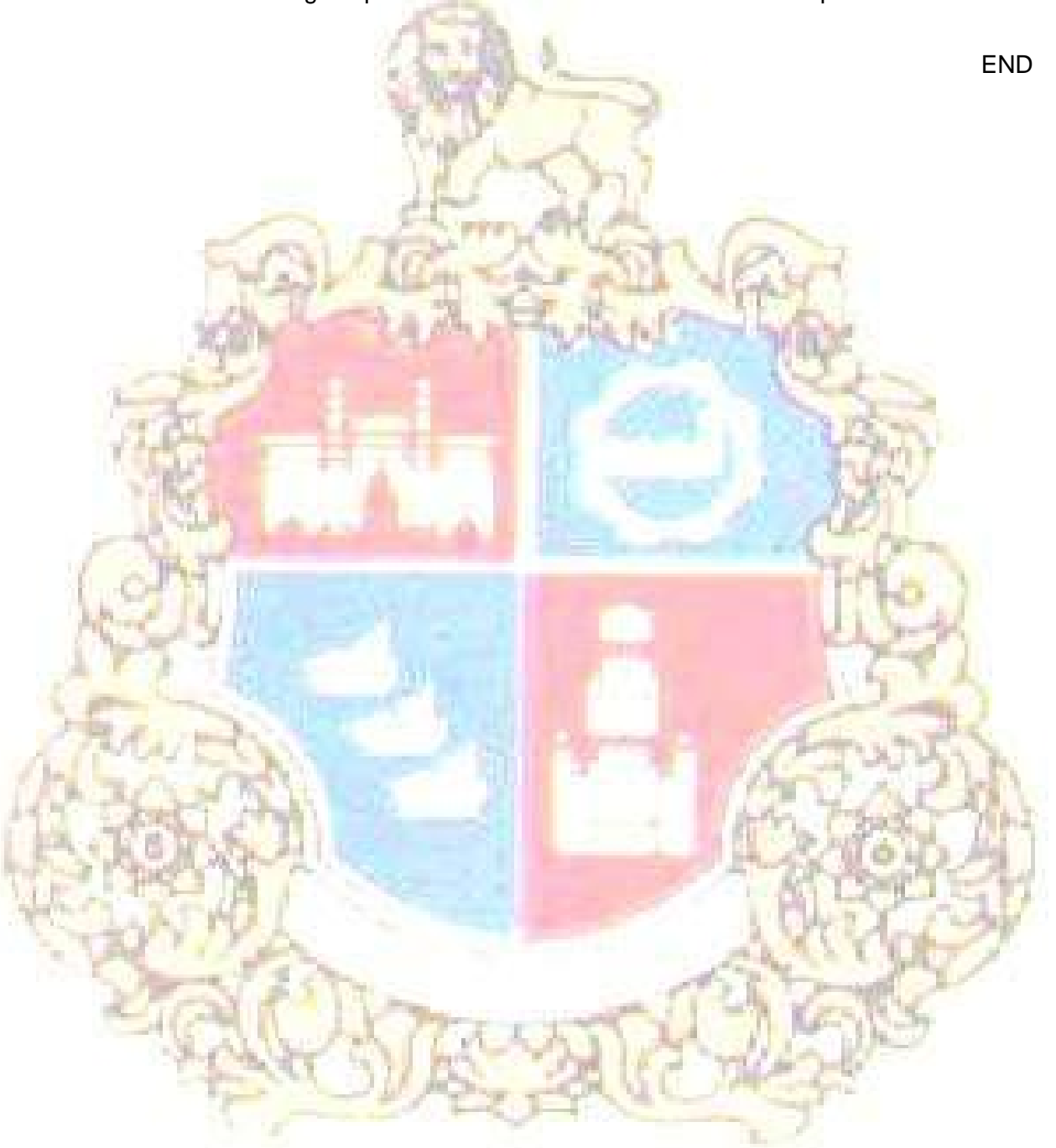
- 4.6.2. Placing the Shotcrete- Each layer of shotcrete is built up by making several passes or loops of the nozzle over the working area. This may be done by moving the nozzle rhythmically in a series of loops from side to side and up and down. The shotcrete shall emerge from the nozzle in a steady, uninterrupted flow. If the flow becomes intermittent due to any cause, the operator shall direct it away from the work until it again becomes constant. The distance of the nozzle from work(usually between 05.an 1.5m) shall be such as to give the best results for the working conditions. The nozzle shall be held perpendicular to the surface of application. However , when gunning through and encasing reinforcing bars, the nozzle shall be held closer and at a slight angle from the perpendicular. Also the mix shall be little wetter than normal, but not so wet as to cause sloughing behind the bar. This procedure forces the plastic shotcrete behind the bar while preventing build up on the front face of the bar. Where bars are closely spaced, more than one bar may be shot from each position.

5.0 **MEASUREMENT AND PAYMENT**

- 5.1. Surface Preparation of brick arch, masonry wall or invert surface for receiving appropriate lining (by removing existing decomposed/damaged lined surface by chiseling ,drilling and cleaning the surface by water jet including removal of weeds, algae etc.) shall be measured in Square meter (sq.m)
- 5.2. Repairs to inner course of brick arch, masonry walls or invert (including breaking out ,extraction ,removal, disposing the debris to approved disposal site as directed and re-constructing the same in cement mortar 1:3) shall be measured in Square meter (sq.m)
- 5.3. Repairs to inner course of brick arch, masonry walls or invert (including breaking out ,extraction ,removal, disposing the debris to approved disposal site as directed and re-constructing the same in min 100 mm thick cement concrete of Grade M30) shall be measured in Square meter (sq.m)
- 5.4. Raising and lowering of manholes / chambers shall be shall be measured in numbers (no.)
- 5.5. Drilling 50 mm diameter holes at any height in the masonry shall be measured in square meter.

- 5.6. Pressure grouting at any height for arch abutment zones and masonry wall surface shall be measured in square meter.
- 5.7. Protective coating of specified thickness shall be measured in square meter.

END



मुंबई नगरपालिका

