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GOVERNMENT OF INDIA- MINISTRY OF RAILWAYS

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MAINTENANCE OF SEWERAGE AND DRAINAGE



CAMTECH/2011/C/SEWERAGE AND DRAINAGE/1.0

March – 2011

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Excellence In Maintenance

Indian Railways

Centre for Advanced Maintenance Technology

Maharajpur, Gwalior - 474 005 (INDIA)

✆ : 0751 - 2470869 & Fax : 0751 - 2470841

Maintenance of Sewerage and Drainage

Foreword

Sewerage and Drainage is the most essential part of any building. If its maintenance is neglected, it will result into problems related to hygiene etc. Therefore, these should be maintained properly.

The booklet prepared by CAMTECH elaborates the maintenance practices generally adopted to keep the system in good condition.

It is expected that this booklet will be quite helpful to civil engineering personnel of Indian Railways engaged in this activity.

CAMTECH/GWALIOR ***S. C. SINGHAL***
DATE: 28.03.2011 ***Executive Director***

Preface

Indian Railways is a big organisation having large assets of civil engineering structures and buildings. These require maintenance throughout the year.

Sewer maintenance functions are too often neglected and are given attention only as emergency arises. This often results into un-hygienic conditions Therefore, it is essential that the maintenance practices involving cleaning of sewers and drains should be periodically exercised to keep the system in good condition.

This booklet is prepared with the objective to provide informative technical details on *'Maintenance of Sewerage and Drainage'* for the guidance of civil engineering personnel involved in maintenance work. This booklet does not supersede any existing instructions from Railway Board, RDSO & Zonal Railways and the provisions of IRWM, BIS codes & reports on the subject.

This booklet is not statutory and contents are only for the purpose of guidance. Most of the data & information mentioned herein are available in some form or the other in various books and other printed matter. For more in-depth information, the relevant codes and reports on the subject may be referred before final implementation of any technique/ or method described in this handbook.

We welcome any suggestions from our readers for further improvement.

CAMTECH/GWALIOR ***S.K.Saxena***
DATE: 28.03.2011 ***Dy. Director/Civil***

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ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

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Where "XX" is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

Sr. No. of C.Slip	Date of issue	Page no. and Item No. modified	Remarks

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Chapter - 1

Introduction

Sewerage and drainage is the most important part for which special attention is required during planning, designing and construction of a sewerage and drainage system. The liquid wastes such as **sanitary sewage**; **sullage or wastes** from bathrooms, kitchen, washing places, etc. and **storm or rain water** collected within the premises are drained into the public sewer or to an individual waste disposal system through drainage.

Sewer maintenance functions are too often neglected and given only as emergency arises. Considering the health hazards that the public at large has to face, it will be appropriate to provide sufficient funds to take care of men, material, equipment and machinery required for efficient maintenance.

The maintenance that helps to protect the capital investment, to prevent serious health hazards when sewage backs up through the plumbing fixtures, ensures an effective and economical expenditure in operating and maintaining the sewerage facilities. It also helps to build up and maintain cordial relations with the public, whose understanding and support are essential for the success of this facility.

In this handbook, various aspects related to maintenance of sewerage and drainage system such as types of maintenance, required tools and equipments, safety hazards and precautions to be taken and procedure to carry out maintenance have been elaborated.

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Chapter - 2

Maintenance of Sewerage System

2.1 General

The optimum use of labour, equipment and material shall be ensured to keep the system in good condition through maintenance of sewerage system. The maintenance really begins with the design and construction of the sewerage system. In order, for this system, to function adequately in so far as health is concerned, it becomes imperative that the maintenance requirements shall be considered at the time of designing sewerage system.

In general, it relates to the work of keeping any installed sewerage facility in a working condition for the benefit of the people.

2.2 Necessity of Maintenance

The sewer system is a closed system of pipes from the waste receptacle to the final disposal point either on land or into a body of water under gravitational or free flow. When the flow is obstructed due to clogged sewer lines, it results in over flowing of manholes or backing up of sewage into a house or structural failure of the system. To avoid such a situation, it is imperative to carry out necessary maintenance to prevent serious health hazards that the public at large has to face.

2.3 Types of Maintenance

There are two types of maintenance of sewerage systems – ***preventive*** and ***emergency***.

- ***Preventive (or routine) maintenance*** is more economical and provides for reliability in operations of the sewer facilities. It is carried out to

prevent any breakdown of the system and to avoid emergency operations to deal with clogged sewer lines or over flowing manholes or backing up of sewage into a house or structural failure of the system. Proper inspection and preventive maintenance is a necessity.

- ***Emergency maintenance (or repairs),*** which would be very rare if proper maintenance is carried out, will also have to be provided for.

2.4 Record keeping

Update maps and profiles of the sewerage system are a must not only for the proper maintenance of the system but also for assessing its adequacy. Records of the location and depth of all sewers and house connections should be kept in sufficient detail and accuracy for locating any sewer in case it becomes necessary to dig it up. Records should be maintained of

- All complaints received regarding sewer blockages and clearance of the same with dates and times.
- The condition of the sewer found at the time of attending to the complaint, damage noticed, if any, should be recorded by the attending staff.
- The record of cleaning of the sewers should be maintained by the staff/gangs responsible for the same.
- All data regarding the construction, repair, rehabilitation of sewers.

2.5 Periodicity

Sewer line gangs should attend to the cleaning and flushing of all sewers at least twice every month. Manholes should be left open for few hours for gases to escape, before any man enters into it. The maintenance gang preferably consists of a supervisor or mate with at least 6 skilled sewer men. The area under each gang will depend on the size of the sewer line (whether surcharged or not) whether cleaning is being done by manual labour or by mechanical sewer machines etc. In case, house gully traps are

to be maintained, special gang of one or two persons who will clean these traps regularly in a phased or planned manner is necessary. The work of each sewer maintenance gang would consist of the following:

- Check manhole condition for deposition of silt, flow, new connections done, damaged walls or steps, manhole covers, clogged vertical pipes in drop manholes etc.
- Check the sewer line between two successive manholes for silting and flow conditions and remove the deposited silt and
- Check for any harmful and extraneous matter entering into the sewer line so that further investigation for the cause and location can be determined
- Check air release valves in rising or force mains, sluice gates or stoppage in the sewer lines, overflow arrangements etc.

2.6 Selection of Sewermen

The persons considered for employment in operation and maintenance of sewerage system should be physically fit. Those with the following disabilities should not be utilized for this purpose.

- A history of fits, blackouts or fainting attacks
- A history of heart disease or disorder
- High blood pressure
- Asthma, bronchitis or a shortness of breath on exertion
- Deafness
- Disease involving giddiness or loss of balance
- Claustrophobia or nervous or mental disorder
- Back pain or joint trouble that would limit mobility in confined spaces
- Deformity or disease of the lower limbs limiting movement
- Chronic skin disease
- Serious defects in eyesight and
- Lack of sense of smell

Note: Employees should be medically re-examined at reasonable intervals taking into account the person's age and duties.

2.7 Procedure for working in a Sewer

To ensure proper safety standards, the following steps should be followed:

Step 1 – Before leaving the depot

a) collect and check all safety equipment and
b) check working location with supervisor and list all known or potential hazards.

Step 2 – On arrival at the site

a) set up adequate road markings and
b) ventilate the system (guarding all openings) on a sewer opening up,
    1. the working manhole
    2. next manhole upstream
    3. next manhole downstream.

Step 3 – Entry procedure

a) check for gases (if in doubt – stay out)
b) tie safety belt and rope before entering
c) check ladders, step iron, etc., for defects (if in doubt, use a rope attached to the safety belt)
d) keep safety ropes, spare lamps, breathing sets, close to working area for immediate use in case of emergency, and
e) if considered safe, enter sewer.

Step 4 – Working inside the sewer

a) check the gas every three minutes, and
b) every three minutes the top man calls to the man working in the sewer. Every message shall be acknowledged.

Step 5 – Completion of the work

a) top man informed and ready

b) ganger (normally last man out) checks that all tools, ropes, etc are out and that the sewer is clear
c) replace all grids, guardrails, manholes covers
d) road signs to be removed and site cleared
e) supervisor to be informed that work is completed, and
f) wash thoroughly before eating or smoking.

2.8 Removal of stoppages and clearing out the deposits in Sewer Lines

Clogging may be due to grit deposition or other detritus, deposition of grease, penetration of roots from adjoining trees, growth of fungi or stagnation of sewage and improper working of pumping units. Sewers may be flushed by fire-hose from the nearest fire hydrant if conveniently located and if the stoppage is too stubborn to respond to flushing, it may be removed by rodding from the next manhole or it may be necessary to dig down to the point where the trouble exists.

2.9 Precautions during Sewer Maintenance

While assisting crews entering a deep manhole or sewer where dangerous gas or oxygen deficiencies may be present, the following should be taken:

a) Allow no smoking or open flames and guard against sparks
b) Erect warning signs
c) Use only safe gas- proof electric lighting equipment
d) Test for noxious gases and oxygen deficiencies to be conducted by
   - using lead acetate paper for presence of hydrogen sulphide and
   - using safety lamps for oxygen deficiencies
e) 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

f) 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. Adequate ventilation should be maintained during the work and the test to be repeated frequently.

g) If the gas or oxygen deficiency is present and it is not practicable to ventilate adequately before workers enter a manhole, mask shall be worn and extreme care shall be taken to avoid all sources of ignition. Workers should be taught how to use the oxygen hose equipment. In These cases, they shall always use permissible safety lights (not ordinary flashlights), rubber boots or non-sparking shoes and non-sparking tools.

h) Workmen descending a manhole shaft to inspect or clean sewers, 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 sewers, at least two men shall be available for lifting workers from the manhole in the event of serious injury.

i) Provision should be made for ventilation and it should be of the forced type which can be provided by a blower (preferably portable air blowers) located at ground level with suitable flexible ducting to displace out air from the manhole. Portable air blowers,

- for ventilating sewer manhole are recommended for all tank, pit or manhole work where the presence of noxious gases, vapours or oxygen deficiency is detected
- motors for these shall be of weather proof and flame-proof types; compression ignition-diesel type (without sparking plug).
- when used, these shall be placed not less than 2m 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.

2.10 Safety Equipments normally required in Sewer Maintenance work

The various safety equipments that are normally required in sewer maintenance work are used for detection of various gases and oxygen deficiency. The sewerman should be equipped with the following equipment for own protection:

- Safety helmet preferably with cap lamp (explosion proof);
- Safety belt;
- Protective gloves;
- Overall, heavy coat or other heavy duty protective clothing preferably waterproof;
- Knee or thigh length safety boots with toe protection and anti-spark studs;
- Gas masks and breathing apparatus;
- Eye protectors;
- Portable lighting equipment;
- Non-sparking tools;
- Portable air blowers;
- Gas test equipment, such as safety candle lamps, Davy's safety lamps, lead acetate papers and electronic gas detectors;
- Inhalators;
- Diver's Suit; and
- First aid equipment

2.11 Equipments and Devices required for Sewer cleaning work

Sewer cleaning works require usual implements like pick axes, manhole guards, tripod stands, danger flags, lanterns, batteries, safety lamps, lead acetate paper, silt drums, ropes, iron hooks, hand carts, plunger rods, observation rods, shovels etc. In addition, sewer cleaning work calls for the following special equipments and devices such as

- ***Portable pump set*** non-clogging type either running on diesel or petrol engine may be used in cases where sewers are completely blocked and sewage has accumulated in manholes.
- ***Manila rope and cloth balls*** may be used for cleaning small diameter sewers up to 300 mm dia. Flexible bamboo strips tied together are used for this purpose.
- ***Sectional sewer rods*** are used for cleaning small sewers. The sewer rods may be of bamboo or teakwood or light metal usually about one meter long at the end of which is a coupling which remains intact in the sewer but can be easily disjointed in the manhole.
- ***Sewer cleaning bucket machine*** consists of two powered winches with cables in between. Various bucket sizes are available for sewers of 150 mm to 900 mm in size.
- ***Dredger (Clam-shell)*** consists of a grab bucket on a wire rope which is lowered into the manhole in open condition with the help of a crane and pulley. The disadvantage in this system is that it cannot clean the corners of the catch-pits of manholes.
- ***Rodding machine with flexible sewer rods*** consists of a machine which rotates a flexible rod to which is attached the cleaning tool such as augur, corkscrew or hedgehog and sand cups.
- ***Scraper*** used for sewers of diameter larger than 750 mm is an assembly of wooden planks of slightly smaller size than the sewer to be cleaned. Where the scraper can not be lowered through the opening of a manhole, the scraper has to be assembled inside the manhole. Circular scraper is used on small sewers below 350 mm dia for cleaning the body of the line.
- ***Hydraulically propelled devices*** take advantage of the force of impounded water to effectively clear sewers. 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 devices used for this purpose are *flush bag or sewer flusher*, *sewer balls*, etc

- ***Velocity cleaners (Jetting Machines)***, makes use of high velocity water jets to remove and dislodge obstructions, soluble grease, grit and other materials from sanitary, storm and combined sewage systems. Basically it includes a high pressure hydraulic pump capable of delivering water at variable pressure up to about 80 kg/sq cm through a flexible hose to a sewer cleaning nozzle. Moreover by varying the pressure suitably, the nozzle itself acts as a jack hammer and breaks up stubborn obstructions.
- ***Suction units (Gully Emptier)*** create vacuum required of mud, slurry, grit and other materials from sanitary, storm and combined sewerage systems. The vacuum created is such as to siphon the materials from the deep manholes catch-pits etc. having depth ranging from 1m to 8m in normal cases with an option to suck additional 4m with the help of special accessories for the purpose. The unit can be vehicle or trolley mounted. This machine is very much useful in de-silting surcharged manholes and in routine course the manholes can be de-silted without the workers getting down into the manhole.
- ***Pneumatic plugs*** are used for a) isolating the gravity sewers for low pressure testing of sewer b) stopping the flow of sewage in the sewer line to carry out structural repairs c) stopping the flow to carry out routine maintenance on the downstream side of plugged sewer line.

2.12 Hazards

Personnel engaged in operation and maintenance of sewerage systems including sewage pumping stations are exposed to different types of occupational hazards like physical injuries, injuries caused by chemicals and radioactive wastes, infections caused by pathogenic organisms in sewage and dangers inherent with explosive or noxious vapours and oxygen deficiency.

2.12.1 Gases in sewerage system

Sewer gas is a mixture of gases in sewers and manholes containing abnormally high percentage of carbon dioxide, varying amounts of methane, hydrogen sulphide and low percentages of oxygen caused by septic action through the accumulation of organic matter inside the sewer.

The actual hazard is due to the presence of high levels of methane, forming an explosive mixture or the oxygen deficiency or hydrogen sulphide in excess of permissible levels. Sometimes trade wastes may also contribute to other gases like chlorine, ammonia, sulphur dioxide etc.

- ***Chemical asphyxiants*** are substances like carbon monoxide which by combining with the haemoglobin of the blood or with some constituents of the tissues either prevent oxygen from reaching the tissues or prevent the tissues from using it.
- ***Irritants*** are substances like chlorine which injure the air passage and lungs and induce inflammation in the surface of the respiratory tract.
- ***Volatile solvents and dug-like substances*** exert little or no effect on the lungs but affect the nervous system including anaesthesia. Inorganic and organic metallic poisonous substances in volatile form prove toxic after their absorption in to the body.
- ***Combustible vapours*** will burn as long as they are in contact with flame, spark or a heated material having a temperature equal to or greater than the ignition temperature of the gas or vapour provided there is enough oxygen present for combustion.

2.12.2 Gas emergency

- If a gas emergency occurs, everyone should immediately put on their escape sets (breathing apparatus) and alarm raised.
- The top men are trained rescuers and they should down the rescue sets and await the men working in sewer to come out. The top men shall attempt to rescue the man inside sewer with all the equipment at their disposal.

- If there is a casualty, he should be propped up out of water in a comfortable position. Immediately call the emergency services (ambulance, fire brigade). When the victim has gas mask put on if he is breathing a rescuer should always be with him because he may vomit thereby choking the supply of oxygen.
- Guidelines for giving first-aid to a gas victim are given below :
  - Re-move him to fresh air as soon as possible.
  - Apply artificial respiration with oxygen resuscitation if he is not breathing. If one is not available, apply mouth to mouth breathing; and
  - Keep him lying down and wait for an ambulance.

2.12.3 Equipment and simple tests for detection of gases and oxygen deficiency

- ***Combustible gas indicators:*** Used for testing the atmosphere for hazardous concentration of inflammable gases and vapour and for making quantitative estimates of the percentage of combustible gas present. The types of combustible gas indicator may be selected to suit the gas or vapour usually encountered.
- ***Carbon monoxide indicator:*** May be used to detect the percentage of the gas present. They are very sensitive to low concentrations of gas and reliably indicate low but dangerous concentrations of carbon monoxide.
- ***Colorimetric detectors:*** Used to detect specific gases like carbon monoxide, hydrogen sulphide etc. When a sample of atmosphere is drawn into the instrument, the specific gas reacts chemically with the special substance in the detector producing a change in colour. In the Carbon monoxide detector the chemical used is iodine pentoxide or palladium chloride. In hydrogen sulphide detector the chemical used is lead acetate.
- ***Oxygen deficiency indicator:*** An adaptation of the flame safety lamp generally used by miners for testing the atmosphere suspected of being deficient in oxygen. When the oxygen content in the atmosphere is as

low as 16% or lower; the flame will be extinguished. At altitudes more than 1500 m above sea level, the flame may continue to burn even if the percentage of oxygen in the atmosphere is less than 16%.

- ***Simple test:*** In the absence of the indicators and detectors mentioned above, the following simple tests must be conducted after providing sufficient forced or natural ventilation. **In asphyxiating conditions**, a safety lamp must be used. The lamp should burn continuously for at least 5 minutes in the atmosphere under test. It is essential to check if the lamp is undamaged before being used. **For hydrogen sulphide**, a filter paper moistened with 5% solution of lead acetate is exposed for five minutes to the atmosphere under test. The presence of hydrogen sulphide gas is indicated by the paper turning grey or brown. The greater the percentage of the gas, the darker will be the colour.
- ***Detectors and indicators for various gases and oxygen deficiency normally encountered in sewage works are as follows*:**

Gas or vapour	Detector
Hydrogen Sulphide	Lead acetate impregnated paper (qualitative), Hydrogen Sulphide ampoules, Hydrogen Sulphide detector (qualitative)
Methane	Combustible gas indicator, Oxygen deficiency indicator, Methane alarm
Carbon dioxide	Oxygen deficiency indicator
Nitrogen	Oxygen deficiency indicator
Oxygen	Oxygen deficiency indicator
Carbon monoxide	Carbon monoxide indicator, Carbon monoxide tube (quantitative)
Hydrogen	Combustible gas indicator, Oxygen deficiency indicator
Gasoline	Combustible gas indicator, Oxygen deficiency indicator (for concentration over 0.3%)
Sludge	Combustible gas indicator, Oxygen deficiency indicator, Methane alarm
Chlorine	Aqueous ammonia, Odour

2.13 Precautions against Infection

The personnel working in sewerage maintenance systems are prone to infections and hence the precautions as follow should be taken

- The workers should be educated about the hazards of waterborne diseases such as typhoid and cholera through sewage and tetanus through cuts and wounds. Cuts and grazes should be covered with water proof plasters. Effective immunization of workers against diseases such as typhoid, cholera, tetanus, etc, should be done by vaccination.
- The importance of personal hygiene should be emphasized and the worker should be instructed to keep finger nails short and well trimmed, wash hands with soap and hot water before taking food or smoking and to keep fingers out of nose, mouth and eyes, because the hands carry most infection.
- Use of rubber gloves shall be insisted so that sewage or sludge does not come in direct contact with hand. Before starting work, skin likely to be exposed to sewage should be covered with barrier cream.
- The worker should be provided with a complete change of work clothes to be worn during working hours. Gums boots should also be provided for the workers.
- When the work is completed, thoroughly wash all contaminated parts of the body.

2.14 Emergency Maintenance

Emergency maintenance becomes necessary for removal of obstructions in sewers caused by excessive silt accumulation or damage leading to the break down of the system with flows much lower than the normal.

- For locating the exact position of blockages, it is necessary to commence observation from the overflowing manholes down the line until the first manhole with little or no flow is reached.
- In the case of simple blockages, the split bamboo rods can be effectively used. The end of the bamboo rod is tied with cloth to make a small ball of 30 to 50 mm thick and is inserted in to sewer line from the lower manhole where there is little or no sewage flowing.
- In case of persistent blockage, flexible bamboo splits are inserted from the upper manhole also. This can be done by an experienced person even through the manhole is filled with sewage. The operation o striking against the blockage is carried out simultaneously from both ends continuously till it is removed.
- Sectional sewer rods with a cutting edge are also used where available. A ferret in conjunction with a fire hose is also used for removing sand blockages. Sewer jetting machines and gully emptiers are successful and effective also in removing blockages.
- If the damage to the sewer is extensive and is caused by poor foundation then the stretch between the two manholes may have to be re-laid on a proper foundation.
- In the case of small diameter sewer which is broken to remove the blockage, repair can be affected by using a piece of pipe one size larger than the one being repaired. The patch should be the shape of the cut and near the same size and should be well cemented on with cement mortar.

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Chapter - 3

Maintenance of Drainage System

3.1 General

The object of the drainage system is to collect and carry the wastewater for suitable disposal. The wastewater for drainage includes domestic, industrial and storm water. All the pipeline work is done maintaining correct gradients that would allow surface water to move at self-cleansing velocity so that solid particles remain in suspension while flowing without settling down.

3.2 Open Sullage Drains

Open sullage drains should be maintained in a thoroughly satisfactory condition; cleaning and flushing should be done at least twice a month or more often, as considered necessary. Soak-pit should be dug up and cleaned at least once a month or as required and fresh broken stones, broken bricks or cinder filled in.

3.3 Storm Water Drains

Storm water drains should be provided to prevent flooding caused by rainfall. These drains should be examined particularly before the commencement of monsoon, to ensure correct grades. Out falls should be particularly examined with a view to ensure satisfactory disposal of the storm water.

All storm-water drains should be periodically rodded by means of drain rods and a suitable rubber or leather plunger. After rodding, they should be thoroughly flushed with clean water. Any obstruction found should be removed with suitable drain cleaning tools.

3.4 Surface Drains

Surface drains should be examined frequently and there should be no stagnation of sullage near the premises. Gully traps with gratings should be examined wherever installed and prompt action taken for renewal and replacements necessary.

3.5 Subsoil Drains

All subsoil drains should be periodically examined for obstruction at the open joints due to the roots of plants or other growth. These should be sited so as not to endanger the stability of the buildings or earth work.

3.6 Disposal Works

All sullage disposal works should be examined once a quarter and their sanitary condition ensured. When an appreciable extent of silting has taken place, septic tanks should be cleaned in co-ordination with the Medical Department whose responsibility lies in either doing it on contract or departmentally.

3.7 Periodical Cleaning of Drainage System

The following operations shall be carried out during periodical cleaning of a drainage system:

- The covers of inspection chambers and manholes shall be removed and the side benchings and channels scrubbed.
- The interceptive trap, if fitted, shall be adequately cleaned and flushed with clean water. Care shall be taken to see that the stopper in the rodding arm is securely replaced.
- All lengths of main and branch drains shall be rodded by means of drain rods and a suitable rubber or leather plunger. After rodding, the drains shall be thoroughly flushed with clean water. Any obstruction

found shall be removed with suitable drain cleaning tools and the system thereafter shall be flushed with clean water.

- The covers of access plates to all gullies shall be removed and the traps plunged and flushed out thoroughly with clean water. Care shall be taken not to flush the gully deposit into the system.
- Any defects revealed, as a result of inspection or tests shall be made good.
- The covers or inspection chambers and gullies shall be replaced, bedding them in suitable grease or other materials; and
- Painting of ladders/ rings in deep manholes and external painting of manhole covers shall be done with approved paints.

3.8 Gradients and Pipe Sizes

According to IS:1742–1993, the discharge of water through a domestic drain is intermittent and limited in quantity and, therefore, small accumulations of solid matter are liable to form in the drains between the building and the public sewer. There is usually a gradual shifting of these deposits as discharges take place. Gradients shall be sufficient to prevent these temporary building up and blocking the drains. A simple way of working out the gradients required for self-cleansing velocity is to divide the pipe diameter by 2. Thus a 100 mm diameter pipe should have a gradient of 1 in 50 for self-cleansing flow.

Normally, the sewer shall be designed for discharging three times the dry-weather flow flowing half-full with a minimum self-cleansing velocity of 0.75 m/s. The approximate gradients which give this velocity for the sizes of pipes likely to be used in building drainage and the corresponding discharges when flowing half-full are as follows:

Diameter (mm)	***Gradients***	***Discharge*** (cum/min)
100	***1 in 57***	***0.18***
150	***1 in 100***	***0.42***
200	***1 in 145***	***0.73***

230	***1 in 175***	***0.93***
250	***1 in 195***	***1.10***
300	***1 in 250***	***1.70***

In cases, where it is practically not possible to conform to the ruling gradients, a flatter gradient may be used but the minimum velocity in such cases shall on no account be less than 0.61 m/s.

Note - Where gradients are restricted, the practice of using pipes of larger diameter than is required by the normal flow in order to justify laying at a flatter gradient does not result in increasing the velocity of flow but reduces the depth of flow and for this reason is to be deprecated.

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2.	**Code of Practice for Safety Precautions to be taken when entering a Sewerage System**, BIS publication IS:11972 – 1987
3.	**Manual on Sewerage and Sewage Treatment (second edition)**, published by Ministry of Urban Development, New Delhi, December – 1993
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5.	**Code of Practice for Building Drainage,** BIS publication IS:1742 – 1993

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QUALITY POLICY

To develop safe, modern and cost effective Railway technology complying with Statutory and Regulatory requirements, through excellence in Research, Designs & Standards and Continual improvements in Quality Management System to cater to growing demand of passenger and freight traffic on the Railways.

Disclaimer: *The document prepared by CAMTECH is meant for the dissemination of the knowledge/ information mentioned herein to the field staff of Indian Railways. The contents of this handbook/booklet are only for guidance and not statutory. Most of the data & information contained herein in the form of numerical values are indicative and based on the tests/trials conducted by various agencies generally believed to be reliable. While reasonable care and effort has been taken to ensure that information given is at the time believed to be fare and correct and opinion based thereupon are reasonable. Due to very nature of research it can not be represented that it is accurate or complete and it should not be relied upon as such. The reader/user is supposed to refer the relevant codes/ manuals available on the subject before actual implementation in the field.*

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OUR OBJECTIVE

To upgrade Maintenance Technologies and Methodologies and achieve improvement in Productivity and Performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability and Utilisation.

*The contents of this booklet are for guidance only & are **not statutory**. It also does not supersede any existing instructions from Railway Board, RDSO and Zonal Railways & the provisions of IRPWM, IRTMM.*

If you have any suggestion & any specific comments, please write to us:

Contact person:		Director (Civil)
Postal Address:		Centre for Advanced Maintenance Technology, Maharajpur, Gwalior (M.P.) Pin Code – 474 005
Phone	:	0751 - 2470869
Fax	:	0751 – 2470841
E-mail	:	dircivilcamtech@gmail.com