Saudi Electricity Company	الشركة السعودية للكهرباء

SEC DISTRIBUTION CONSTRUCTION STANDARD	SDCS-03 Part-I Rev.01
	DATE: 12 September 2007G

SDCS-03

DISTRIBUTION NETWORK GROUNDING

CONSTRUCTION STANDARD

(PART-I)

UNDERGROUND NETWORK

GROUNDING

Rev. 01

TABLE OF CONTENTS

1.0 GENERAL:

1.1 Scope:

This Grounding Standard describes the technical requirements for grounding the SEC Distribution Network installations.

SEC Distribution System extends from the MV (33 kV, 13.8 kV) feeder outlets of HV / MV Substations down to SEC Customer interface including KWH-Meters and meter boxes.

1.2 Objective:

Objectives of Grounding Standards are as follows:

a) To provide means to direct safely the un-desirable currents from the equipment to earth.

b) To assure that the persons are not exposed to the danger of critical electrical shocks in the vicinity of grounded facilities.

Objective (a) above is achieved by adequately selecting all ground fault current carrying components of Distribution System so that they are capable of safely carrying the ground fault currents for the expected duration of fault clearing times.

Objective (b) above is achieved by providing a ground system of adequately low resistance and arranged in such a way as to limit to safe levels the touch, step and transferred potentials in the events of ground faults.

1.3 Grounding System Elements:

A Grounding System consists of ground conductors, ground rods and equipment to be grounded and the ground accessories. Factors affecting the design of grounding system are as follows:

a) Magnitude and duration of ground fault current.

b) Portion of ground fault current which will pass to the ground.

c) Soil resistivety at fault location.

d) Degree of exposure of grounding system elements to mechanical damage and corrosion (this will influence the choice of materials).

1.4 Summary of Grounding Regulations

1.4.1 System Neutral Grounding

The SEC distribution system is grounded as follows:

a) 33 kV and 13.8 kV Systems

These are 3-wire primary systems with the metal screen /armor of MV cables is grounded at all cable termination points. MV neutral of power transformers is grounded solidly or thru low resistance.

Distribution transformers have DYn11 connections. The secondary side is solidly grounded and connected with MV grounding.

b) LV System

It is a 4-wire system and the LV neutral is multiple grounded at all cable terminations, at MV / LV substations, distribution pillars, and consumer locations.

1.4.2 Metal Work Grounding

All accessible metal work of all distribution equipment is always grounded and connected to system neutral at MV / LV substations, distribution pillars, and consumer locations.

1.5 Grounding Materials and Methods:

Below mentioned grounding methods and materials shall be used for all system configurations.

1.5.1 Grounding and Bonding Materials:

16 mm (5/8 inch) diameter and 1x2400 mm long or 2x1200 copper weld steel ground rods with 70 mm^2 (for MV Grounding) and 35 mm^2 (for LV grounding) bare copper conductor shall be used for grounding applications. Materials are shown on Figures of this Standard.

1.5.2 Grounding Methods:

Details of typical grounding arrangement for different types of distribution system installations are covered in respective clauses. Unless indicated, otherwise on relevant figure, the grounding arrangements shown are for normal soil conditions where it is possible to drive ground rods into the soil without much difficulty. Details of a typical installation of one ground rod are shown in figure 1.

Where it is very difficult to drive the standard ground rod in soil / substation trench, Copper wire buried horizontally to a depth of at least 500 mm is considered equivalent to placing ground rods (6m of wire length equivalent to one rod). This length is in addition to the connecting length of wire between ground rods and from equipment to ground rods. The ground wire should be so installed that as for as possible, it forms a ground mat around the equipment. Two ends of the wire must be connected to the equipment ground terminals. Details of typical arrangements for grounding in rocky soil are shown in figures 9 and 14.

Before deciding to install ground wire in place of ground rods it should be investigated if normal (non rocky soil) soil is available with in a reasonable distance (up to 50 meters) from the installation and along the cable trench. If available the required number of ground rods should be installed in the cable trench in the normal ground and connected to the equipment ground terminals. The connecting ground wire from ground rods to the equipment should form a ground mat around the equipment. Copper ground wire alone (in place of ground rods) should be laid only if normal soil as described above is not available.

For increasing the effectiveness of grounding arrangement the adjacent grounding rods should not be located closer than 4m. In case of difficult situation less than four meters separation is acceptable. However the respective SEC Construction Supervisor should satisfy himself that reduced separation is indeed unavoidable.

In case 2400mm rods can not be used, single 1200mm ground rod can be used with separation of 2m instead of 4 m.

To prevent overheating and features of connections in the grounding systems, following shall be observed:

(a) Unless specified in this standard, the bolted connectors shall not be used.
(b) Bolted connectors, when used, shall be properly tightened.
(c) Penetrox or equivalent oxide inhibiting compound shall be used at all connections of dissimilar metals.
(d) Only the specified compression connectors shall be used.

(e) The compression connectors shall always be crimped using the correct tool and die.

2.0 BONDING OF LV NEUTRAL AND MV GROUNDS.

LV neutral ground and any grounds associated with MV equipment / system shall always be kept bonded.

Separation between LV neutral ground and MV equipment / system ground shall be achieved by grounding LV neutral points which are remote from MV grounds. Minimum distance between any part of MV ground system and nearest LV neutral ground shall be 4 meters.

3.0 GROUND RESISTANCE VALUES AND NUMBER OF GROUND RODS

Every MV equipment installation shall be grounded with minimum of 4 ground rods. In high soil resistivity areas, such as rocky areas, loose soil, etc; additional number of rods or equivalent length of ground wire shall be used to achieve the required ground resistance value.

Soil resistivity can also be improved by adding the appropriate Low Resistivity Materials (LRM) as described in SDCS-03 part 3.

LV Distribution pillar shall be grounded with two ground rods and MV cable terminations with 4 ground rods.

In indoor substation and switching stations ground rods preferably connected to steel reinforcing bars of concrete floor.

Recommended ground resistance limits for different installations should be as under:

System ground	5 Ohms
All distribution Substations	5 Ohms
Surge arresters	5 ohms
LV Distribution Pillar	10 Ohms

4.0 UNDER GROUND MEDIUM VOLTAGE CABLES

4.1 MV 3 - Core Cables

Cable Screen and armor shall be connected to the grounding system of grid substations, MV / LV distribution substations and MV switching equipment as applicable. Typical details are shown in Figure 2.

4.2 MV 1 - core Cables

Cable Screen shall be connected to the grounding system of grid substations, MV / LV distribution substations and MV switching equipment as applicable. Typical details are shown in Figure 3.

4.3 Grounding and Bonding Connections

All bonding and connections to grounding systems shall be made with 70 mm sq bare copper conductor, as shown in Figure 4.

5.0 MV / LV DISTRIBUTION SUBSTATIONS ON CABLE NETWORK

5.1 Ground Mounted, Unit S/S, Package Unit, Platform Mounted, and Fenced MV / LV Substations:

All metal work shall be bonded together and to the substation metalwork grounding system. Each continuous piece of metal that could form part of the path of a ground fault current shall be bonded to its neighbors so that continuity of grounding circuit does not depend on mechanical connections between components.

Grounding arrangements for such substations are shown in Figures 5 to 10.

Neutral of transformer is grounded by bonding neutral bus bar inside LV distribution panel with the body through a 70 mm copper link. MV & LV ground conductors shall be bonded to the common ground wire.
If the transformer and RMU are separated by more than 4 meters, both of them should be treated as independent installations, and each one should be grounded with four ground rods.

5.2 Substations without LV Panels

These substations serve large single point LV customers directly from the transformer terminals.

All metal work shall be bonded together and to the substation metalwork grounding system. Each continuous piece of metal that could form part of the path of a ground fault current shall be bonded to its neighbors so that continuity of grounding circuit does not depend on mechanical connections between components.

The LV neutral shall be connected to MV/LV substation ground.

The customer presents:

- Three phase conductors.
- One neutral conductor.
- One 35 sq mm bare copper ground conductor for connection by SEC. The phase and neutral conductors shall be connected to the appropriate terminals of the transformer. The ground conductor shall be connected to the neutral terminal of the transformer.

Grounding arrangement of such substations is shown in Figure 8.

5.3 Grounding Arrangement

Standard arrangements are shown in Figure 5 through 10 for the range of MV / LV substation designs currently in use. Minimum of 4 ground rods shall be used for the metal work including neutral grounding of all substations, which are supplied from under ground network. For high soil resistivity areas, such as rocky areas refer to clause 3. The ground conductor shall in all cases be 70 mm sq copper.

6.0 GROUND MOUNTED MV EQUIPMENT OTHER THAN MV/LV SUBSTATIONS

6.1 Bonding

The equipment covered are RMU, MV switches etc, when separated from transformer and Bulk Customer Indoor Switchgear.

All metal work shall be bonded together and to the substation metalwork grounding system. Each continuous piece of metal that could form part of the path of a ground

fault current shall be bonded to its neighbors so that continuity of grounding circuit does not depend on mechanical connections between components.

The bonding conductor shall in all cases be 70 mm sq copper.

6.2 Grounding Arrangement

A ground conductor shall surround the entire installation. Dimensions and arrangement of this conductor shall be as shown in Figure 11. For bulk customer indoor switchgear, the grounding arrangement shall be as per Figure 12.

7.0 UNDERGROUND LV NETWORK AND SERVICES

7.1 General

LV distribution system extends from the LV terminals of MV / LV substations Down to and including the load terminals of KWH meter installations. An LV network consists of one or more LV feeders supplied from a transformer. Each feeder serves one or more customers. Customer connections may be made from LV Distribution pillars, LV panels or directly from transformers.

7.2 Bonding

The metal work of all LV network equipment such as LV panels, LV Distribution pillars, covers or enclosures, shall be bonded to the neutral conductor. Bonding conductors shall in all cases be 35 mm sq bare copper.

7.3 Grounding

LV neutral shall be grounded at LV panels, LV Distribution pillars, and SEC consumer interface points. The neutral of each LV feeder shall be grounded through minimum of 4 ground rods. These rods include the ground rods required to be installed at consumer premises.
Each LV distribution pillar shall be grounded through 2 rods as shown in Figure 13.
LV Distribution Pillar grounding in rocky ground is shown in Figure 14.

8.0 METERING INSTALLATIONS

8.1 General

- MV Metering Installations

- LV metering Installations
  Bonding / Grounding requirements of these installations are as follows.

8.2 MV Metering Installation

Metal work bonding / grounding arrangements are the same as given under clause 6.

8.3 LV metering Installations

It shall be essential for the customer to provide grounding at his interface. The customer shall bring the ground wire to the grounding terminals provided in the meter box. The ground wire of the customer shall be connected to the ground terminal inside the meter box. The ground terminal shall be short linked with the neutral.

For more than one KWH-meters at one location, four KWH-meters shall be connected to one ground rod. In case of additional KWH-meters at the premise, additional ground rods shall be provided.

The grounding arrangement is shown in Figure 15 to 19.

9.0 GROUND RESISTANCE MEASUREMENTS

Following methods shall be used for measuring ground resistance:

- Measurement through Fall of Potential method
- Measurement through "Clamp on ground resistance measuring meter"

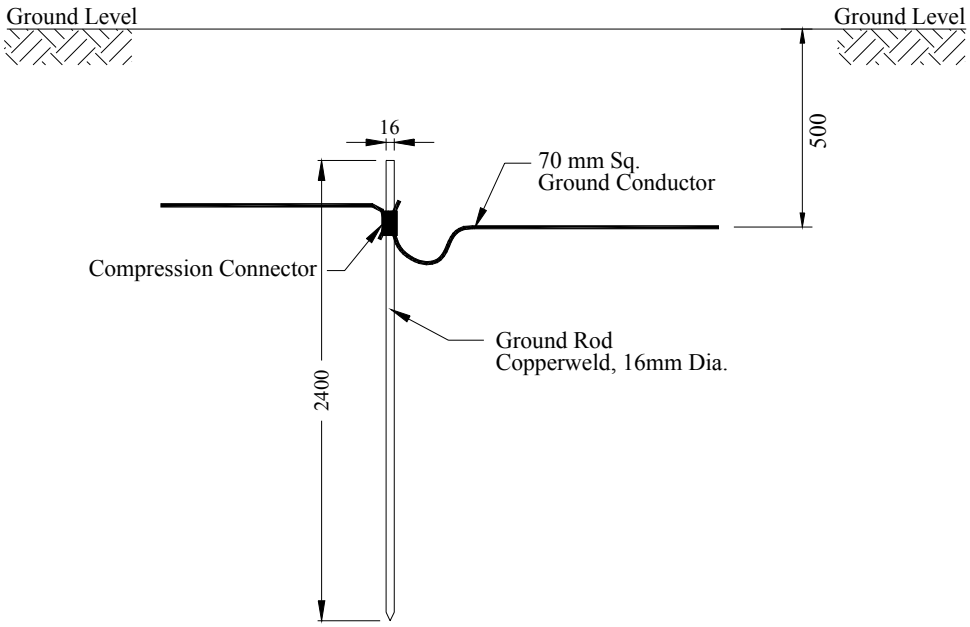


Fig-1 STANDARD ARRANGEMENT GROUND ROD INSTALLATION

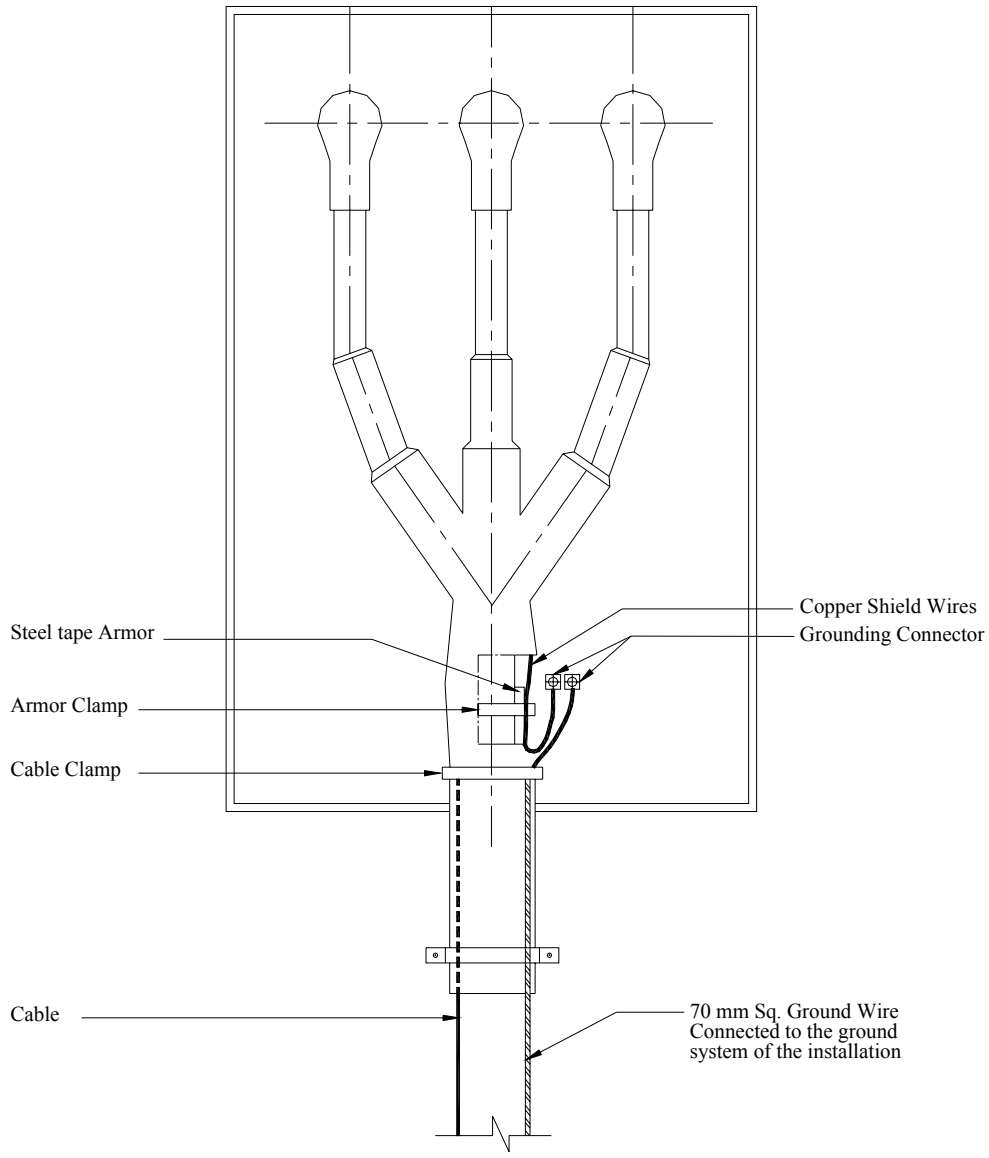


Fig-2 TYPICAL GROUNDING DETAILS INDOOR TERMINATION OF MV THREE CORE CABLE

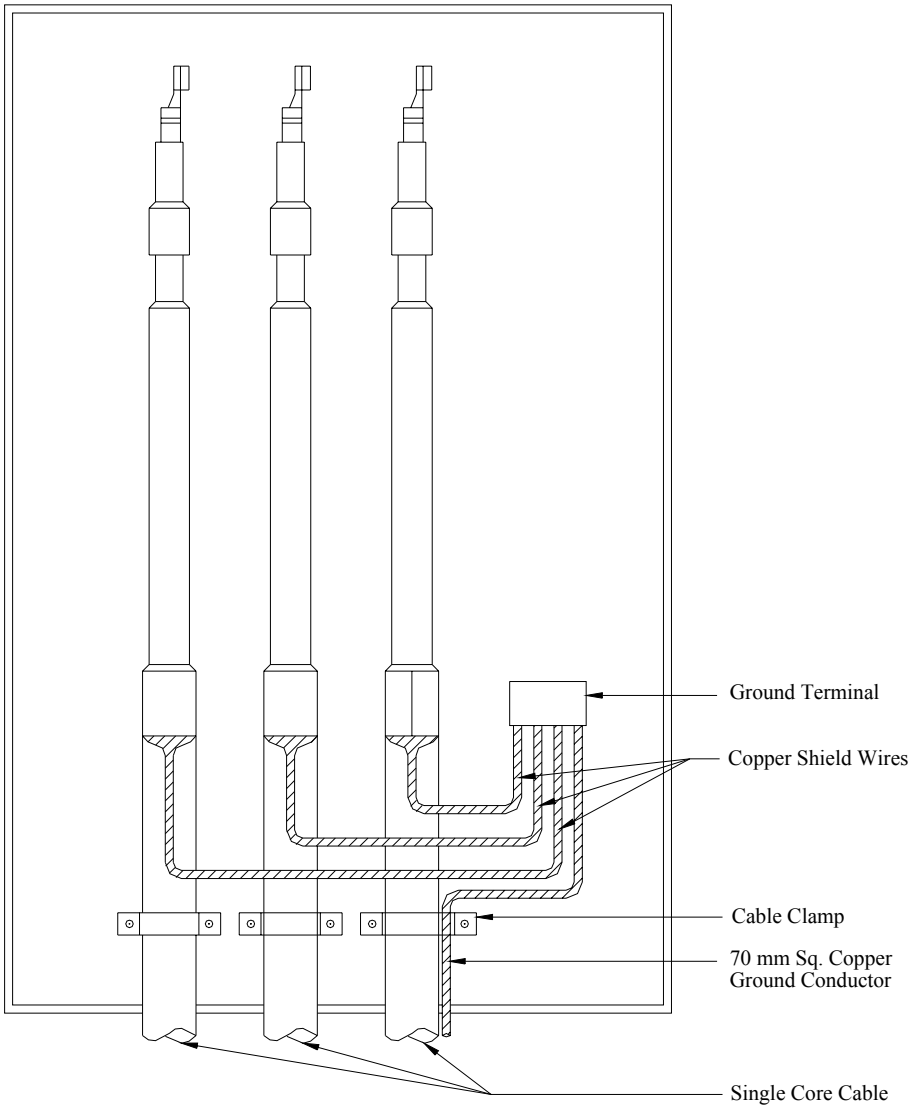
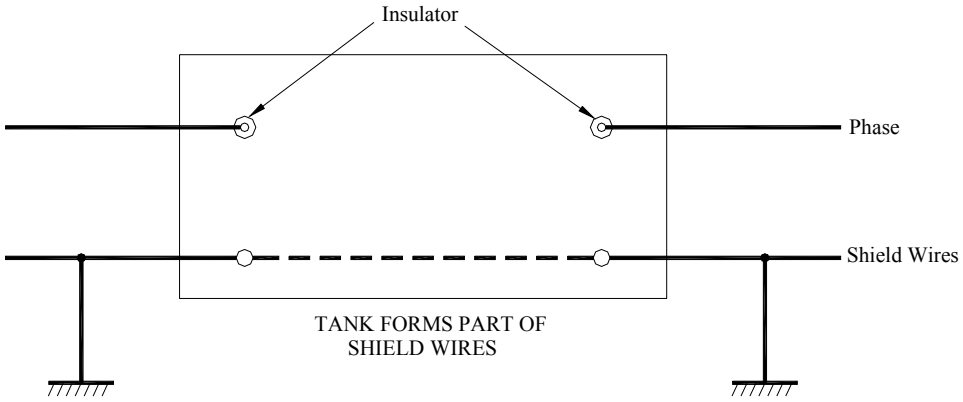
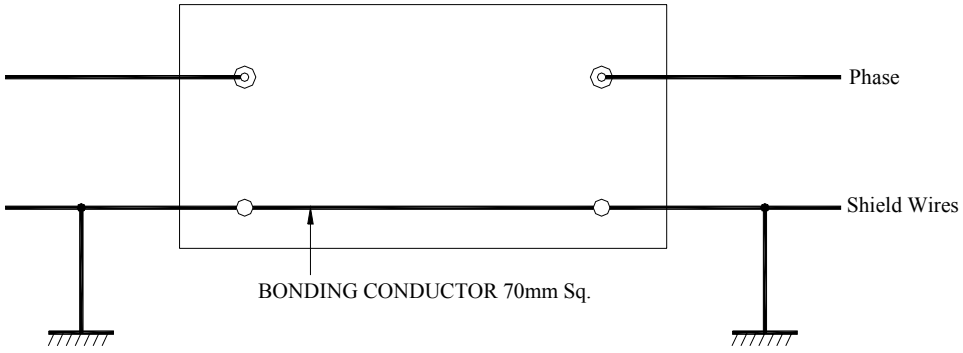


Fig-3 TYPICAL GROUNDING DETAILS INDOOR TERMINATION OF MV SINGLE CORE CABLE

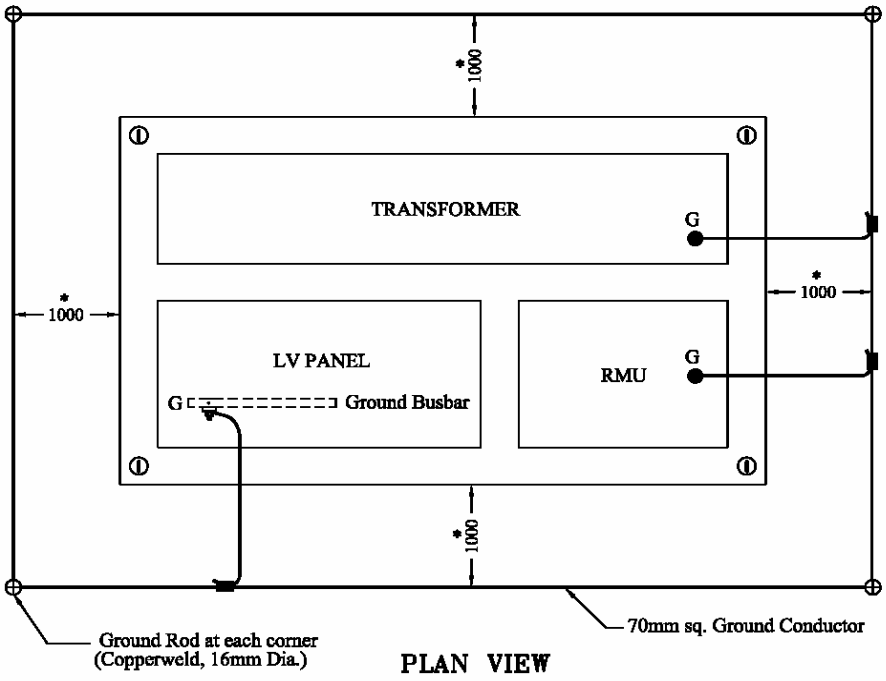


WRONG



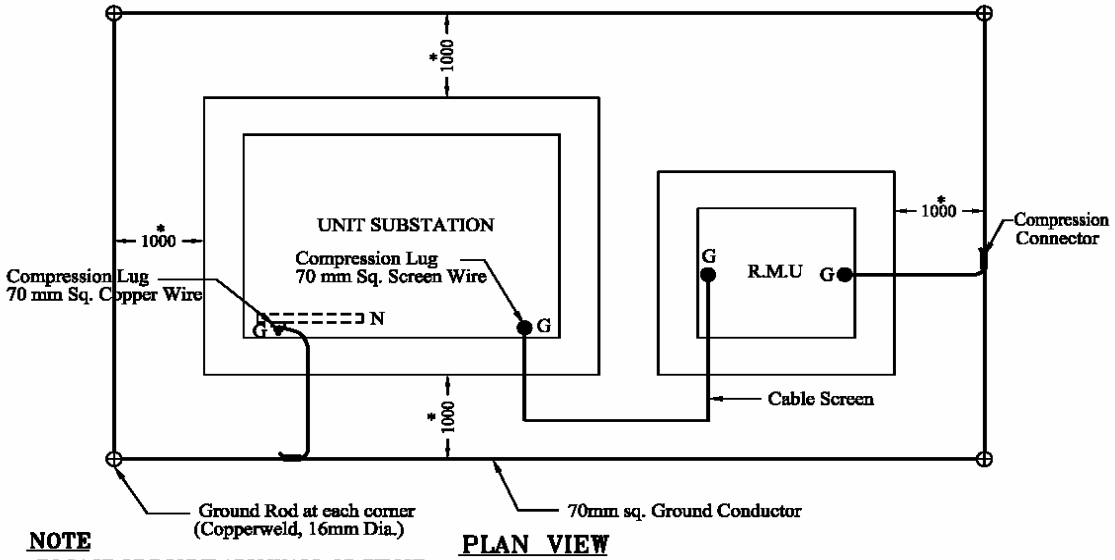
CORRECT

Fig-4 SHIELD WIRE TO METALWORK CONNECTION



* - IN CASE OF BOUNDARY WALL OR FENCE LINE RESTRICTIONS, IT IS ACCEPTABLE TO REDUCE THE 1000mm DISTANCE TO THE MAXIMUM POSSIBLE.

Fig-5 BONDING AND GROUNDING ARRANGEMENT OF MV/LV PACKAGE UNIT

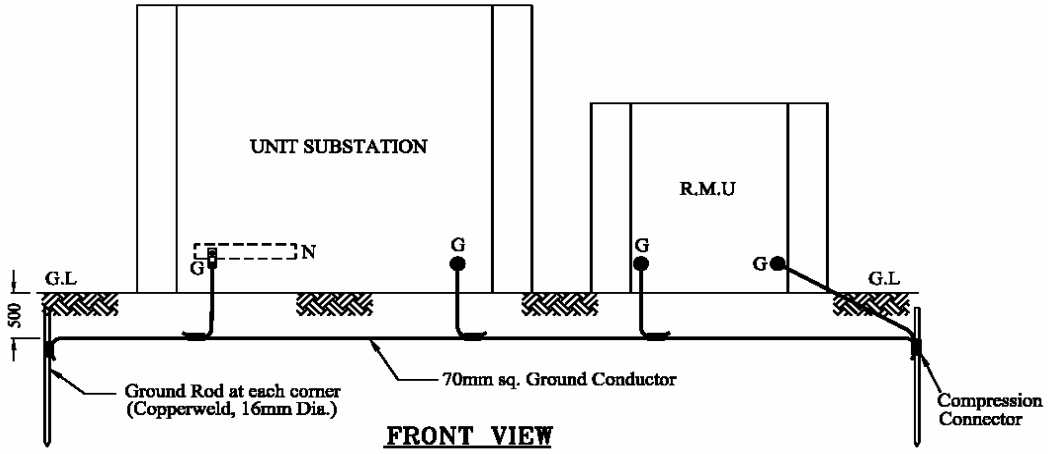


PLAN VIEW

NOTE

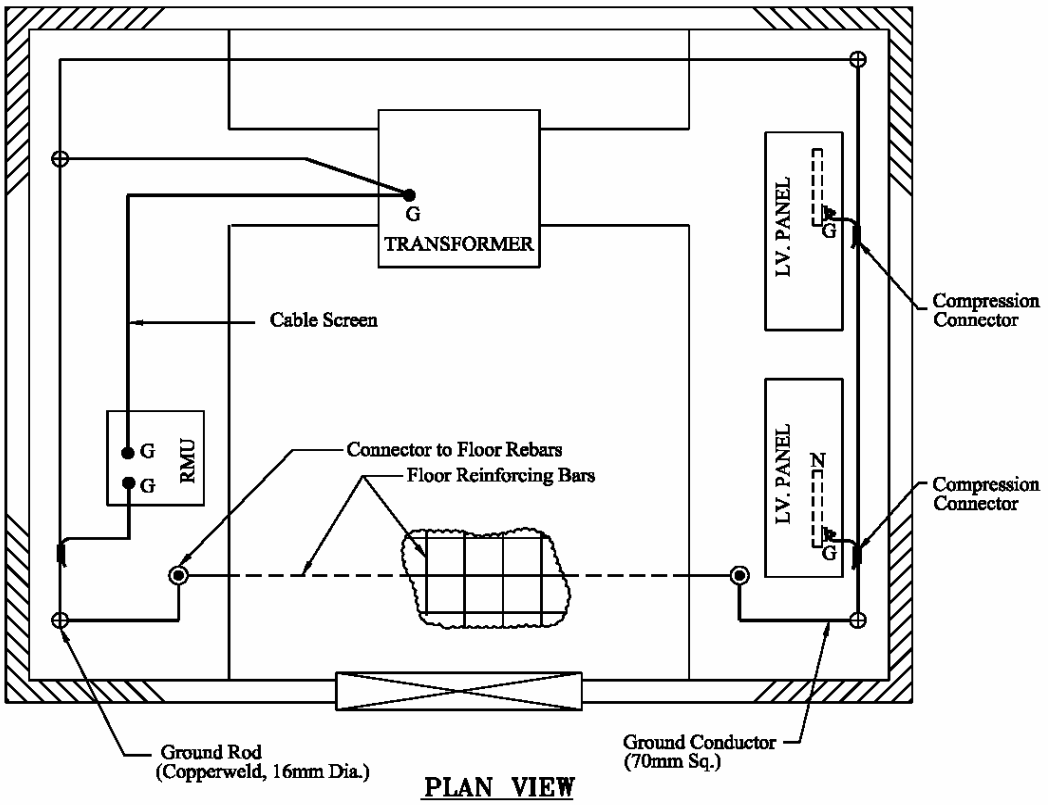
* - IN CASE OF BOUNDARY WALL OR FENCE LINE RESTRICTIONS, IT IS ACCEPTABLE TO REDUCE THE 1000mm DISTANCE TO THE MAXIMUM POSSIBLE.

- NEUTRAL BUSBAR IS CONNECTED WITH CABINET BODY THROUGH LINK.



FRONT VIEW

Fig-6 BONDING AND GROUNDING ARRANGEMENT OF MV/LV UNIT SUBSTATION



PLAN VIEW

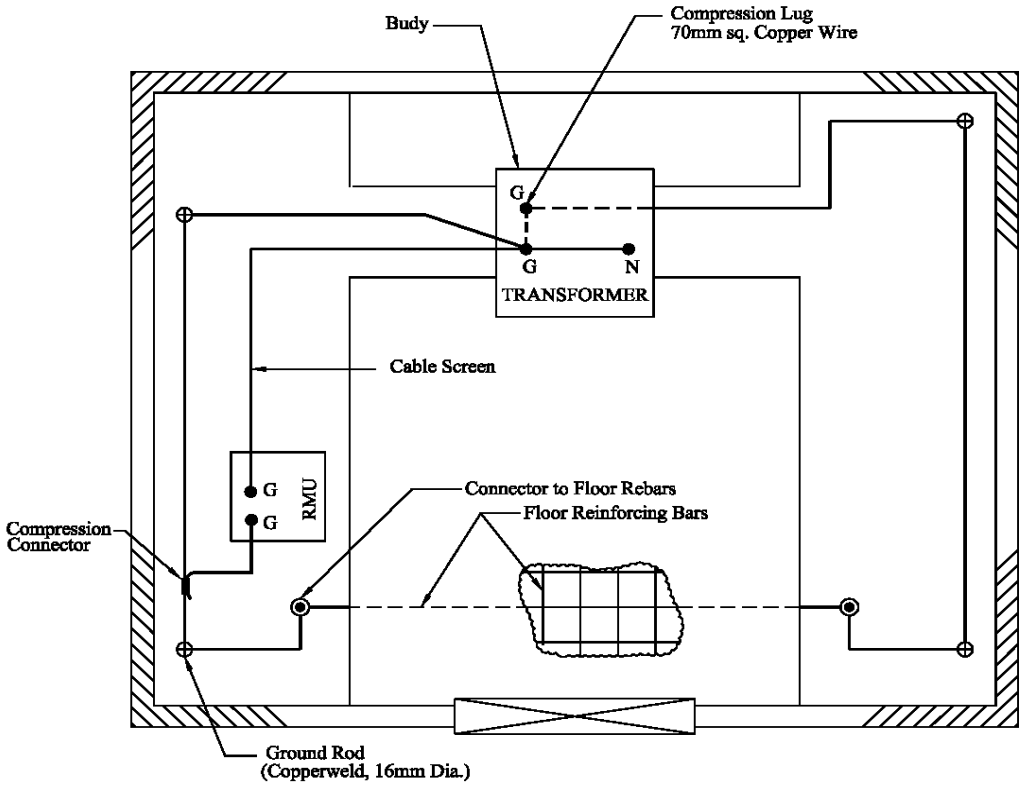
NOTE:

L.V PANEL GROUND CONNECTION, SHOWN AS DOTTED LINE, IS TO BE INSTALLED WHEN THE L.V PANEL IS PROVIDED WITH ONLY ONE GROUND POINT.

◉ CONNECTION TO FLOOR REBARS

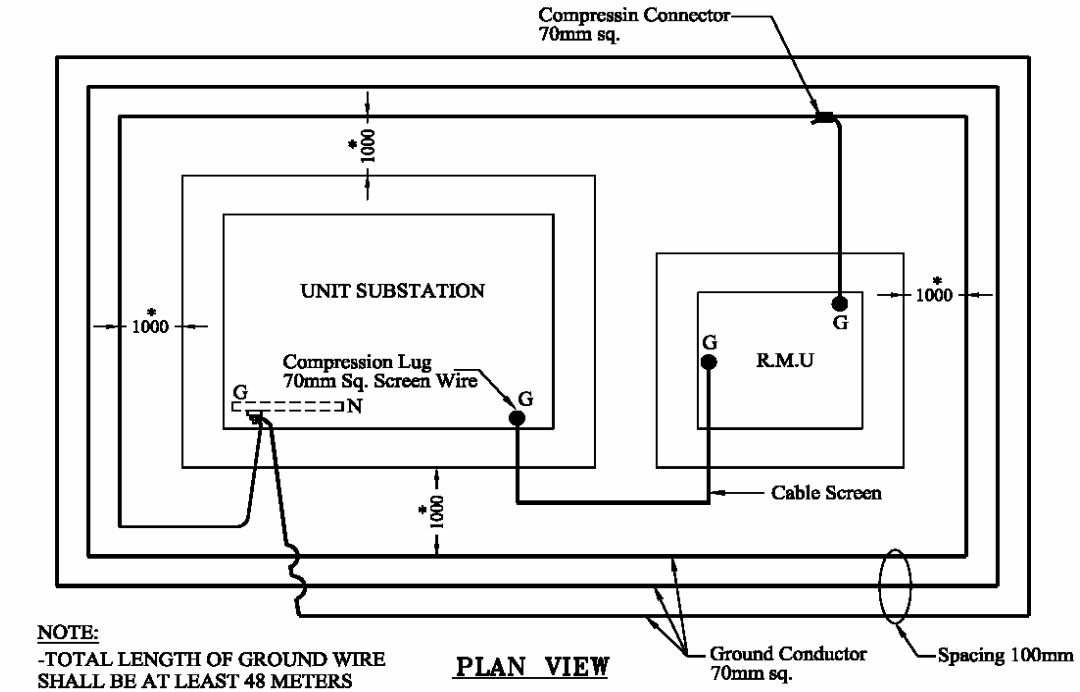
- NEUTRAL BUSBAR (N) IS CONNECTED WITH PANEL BODY THROUGH LINK

Fig–7 TYPICAL BONDING AND GROUNDING ARRANGEMENT INDOOR MV/LV SUBSTATION WITH LV PANEL



PLAN VIEW

Fig–8 TYPICAL BONDING AND GROUNDING ARRANGEMENT
INDOOR MV/LV SUBSTATION WITHOUT LV PANEL

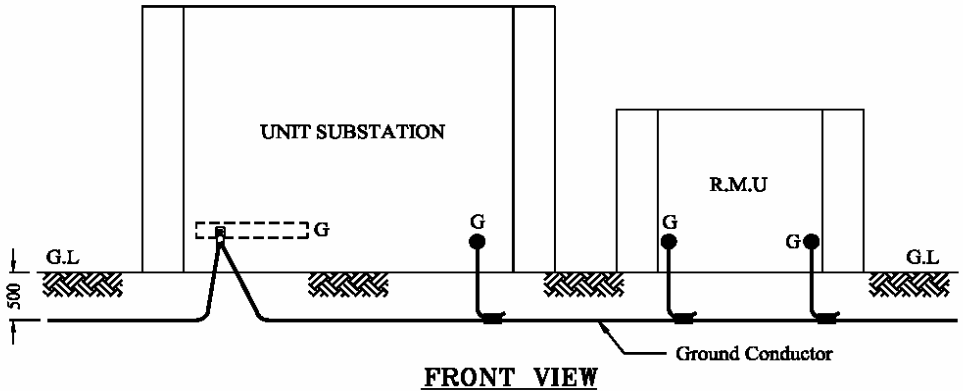


NOTE:
-TOTAL LENGTH OF GROUND WIRE SHALL BE AT LEAST 48 METERS

PLAN VIEW

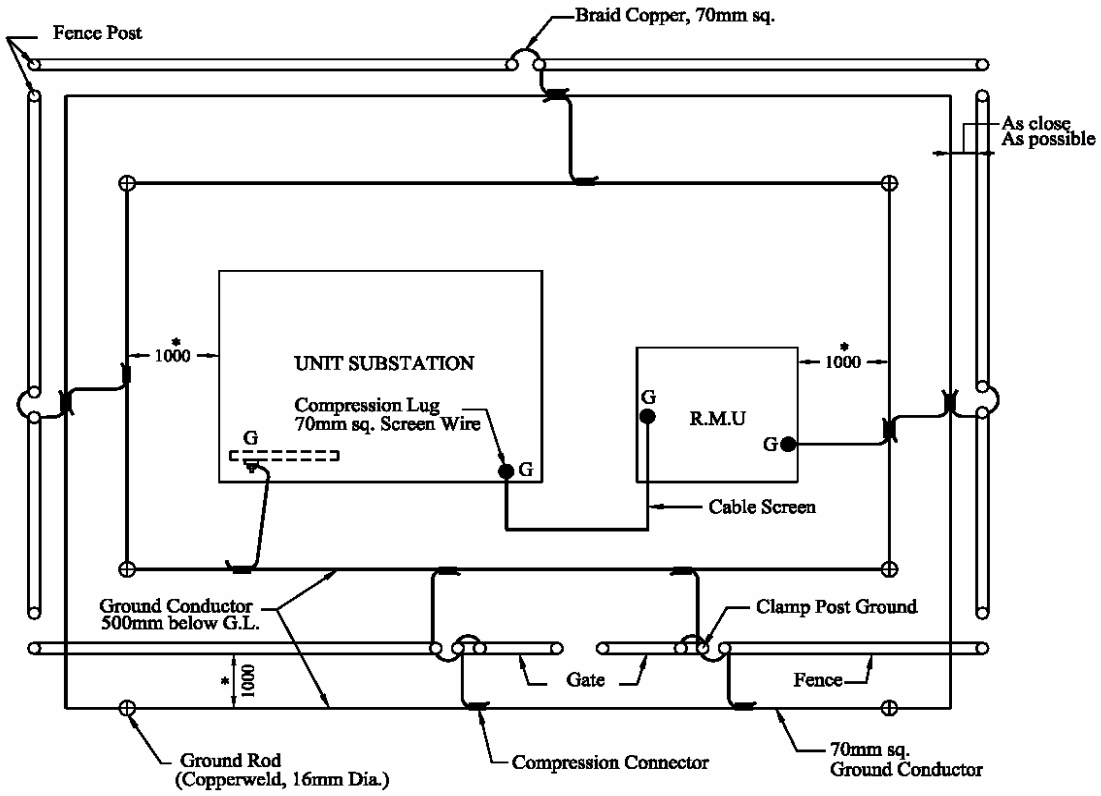
* - IN CASE OF BOUNDARY WALL OR FENCE LINE RESTRICTIONS, IT IS ACCEPTABEL TO REDUCE THE 1000mm DISTANCE TO THE MAXIMUM POSSIBLE.

- NEUTRAL BUSBAR IS CONNECTED WITH CABINET BODY THROUGH LINK.



FRONT VIEW

Fig-9 BONDING AND GROUNDING ARRANGEMENT PADMOUNTED MV/LV UNIT SUBSTATION ON ROCKY SOIL



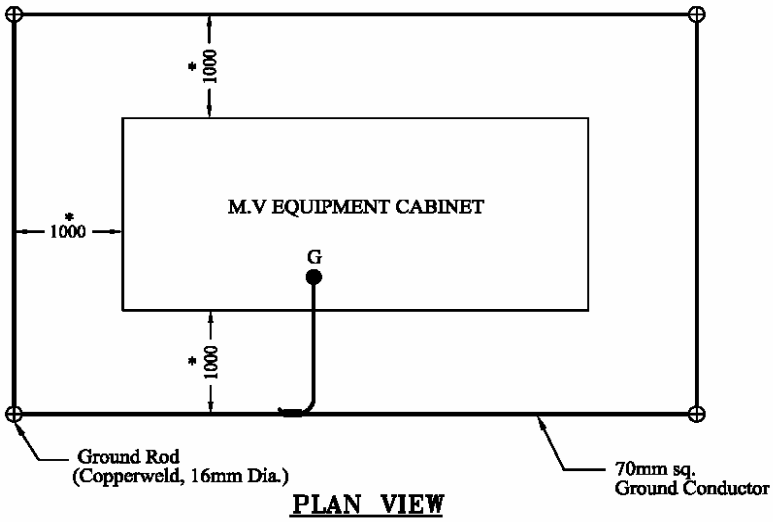
PLAN VIEW

NOTE:

* - IN CASE OF BOUNDARY WALL OR FENCE LINE RESTRICTIONS, IT IS ACCEPTABLE TO REDUCE THE 1000mm DISTANCE TO THE MAXIMUM POSSIBLE.

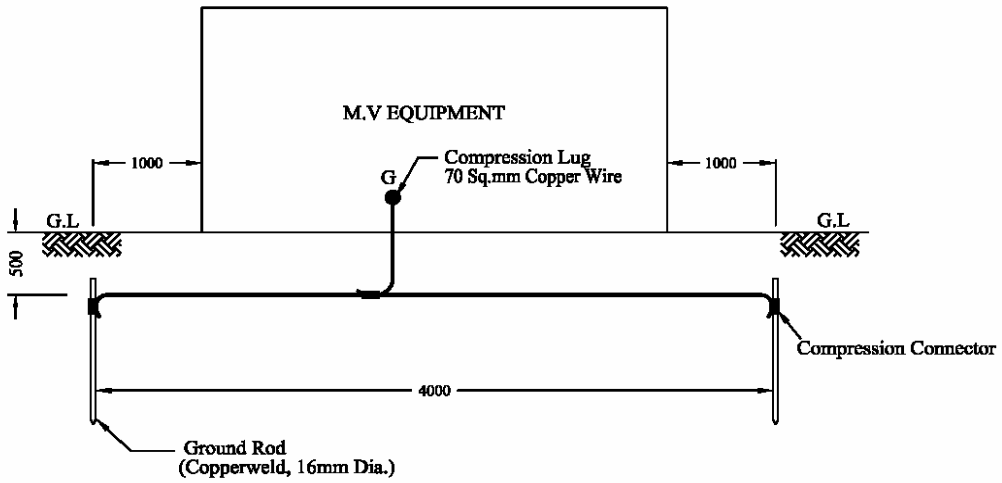
- NEUTRAL BUSBAR (N) IS CONNECTED WITH CABINET BODY THROUGH LINK

Fig-10 TYPICAL BONDING AND GROUNDING ARRANGEMENT FENCED UNIT SUBSTATION



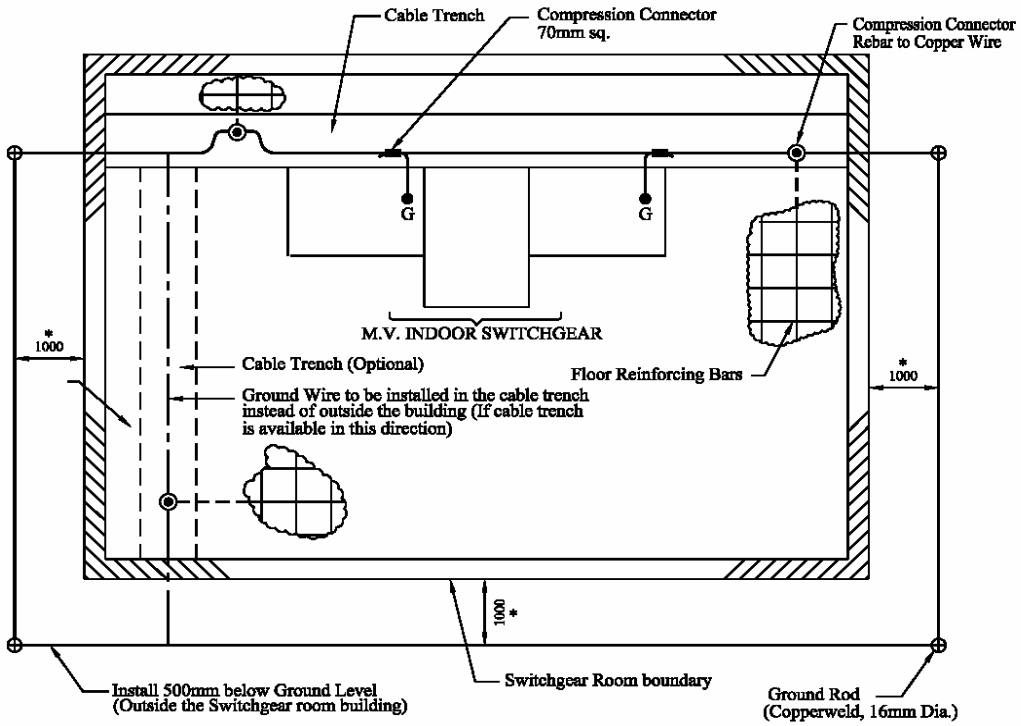
PLAN VIEW

* - IN CASE OF BOUNDARY WALL OR FENCE LINE RESTRICTIONS, IT IS ACCEPTABLE TO REDUCE THE 1000mm DISTANCE TO THE MAXIMUM POSSIBLE.



FRONT VIEW

Fig-11 BONDING AND GROUNDING ARRANGEMENT PADMOUNTED MV EQUIPMENT OTHER THAN MV/LV SUBSTATIONS



PLAN VIEW

◉ CONNECTION OF FLOOR RE-BARS TO THE GROUND CONDUCTOR

✱ - IN CASE OF BOUNDARY WALL OR FENCE LINE RESTRICTIONS, IT IS ACCEPTABLE TO REDUCE THE 1000mm DISTANCE TO THE MAXIMUM POSSIBLE.

Fig–12 BONDING AND GROUNDING ARRANGEMENT MV INDOOR SWITCHGEAR FOR BULK CUSTOMER

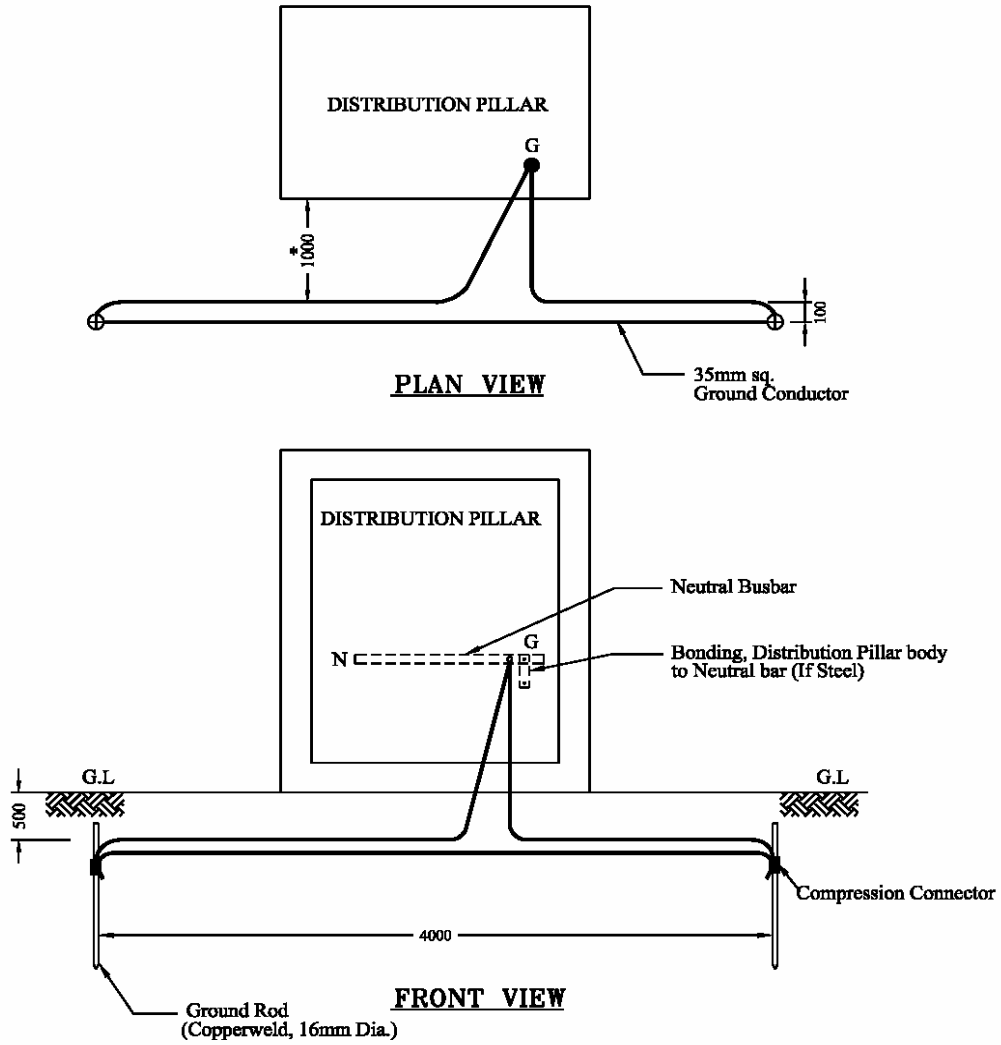
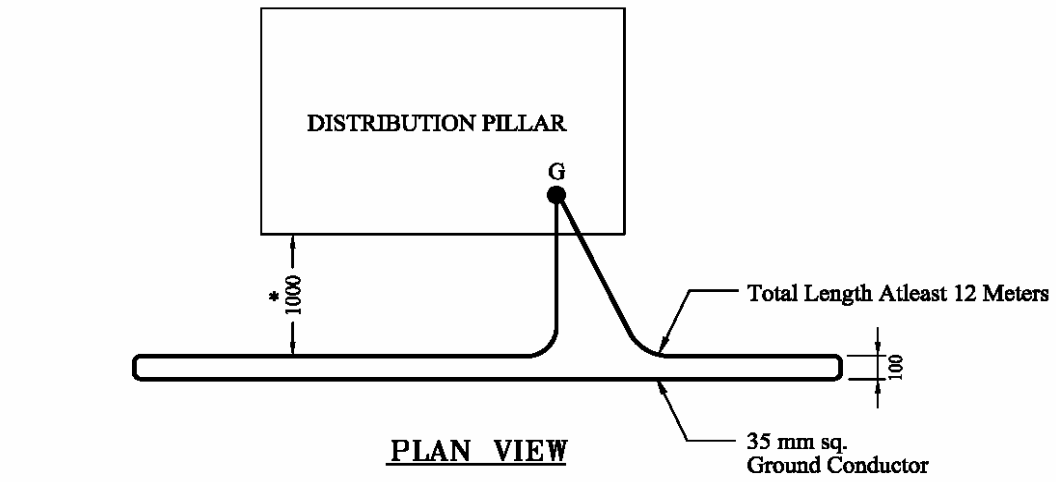
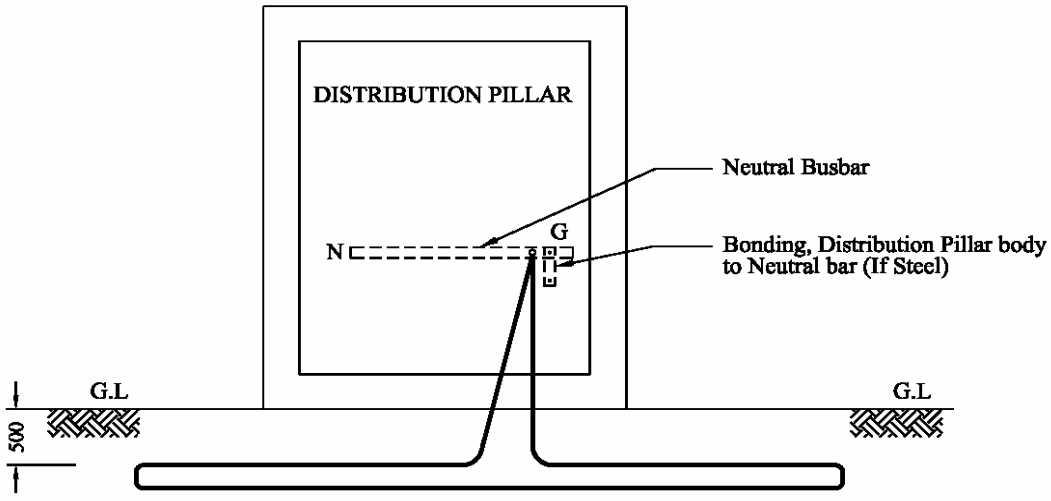


Fig-13. BONDING AND GROUNDING ARRANGEMENT - LV DISTRIBUTION PILLAR

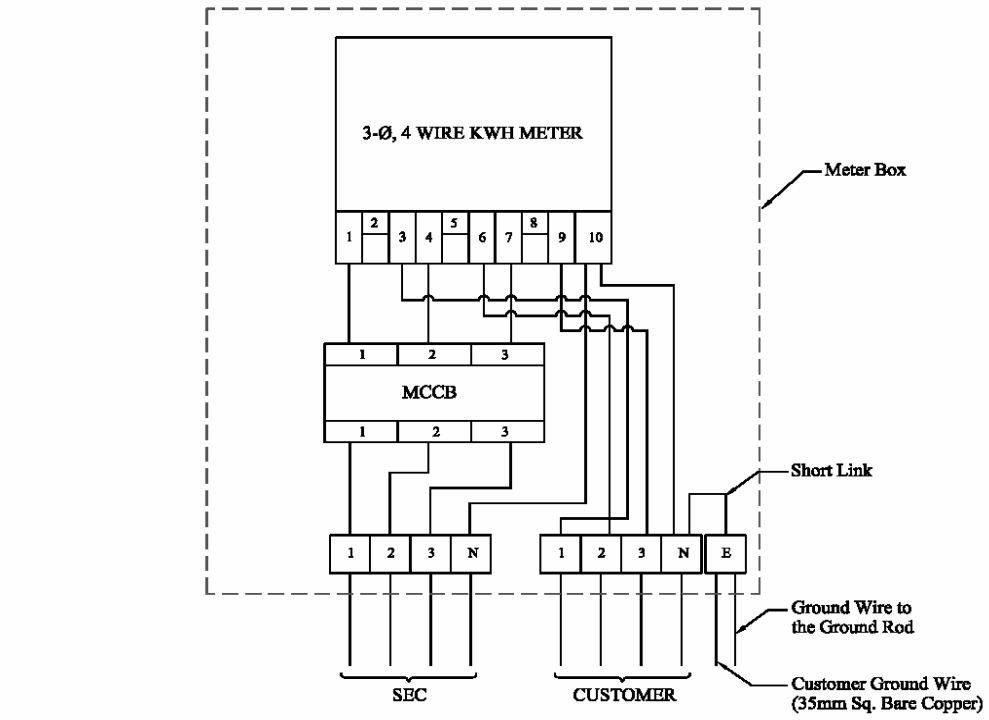


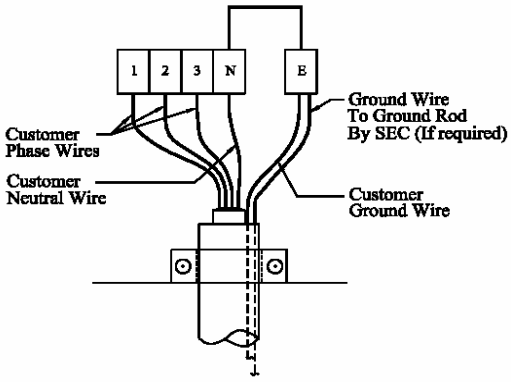
PLAN VIEW



FRONT VIEW

Fig–14 BONDING AND GROUNDING ARRANGEMENT
LV DISTRIBUTION PILLAR ON ROCKY SOIL





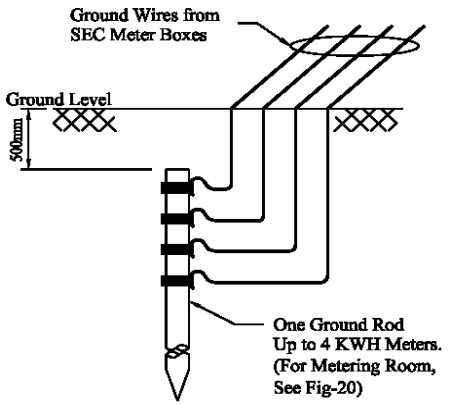


Fig-15 WHOLE CURRENT KWH-METERS GROUNDING INSTALLATION

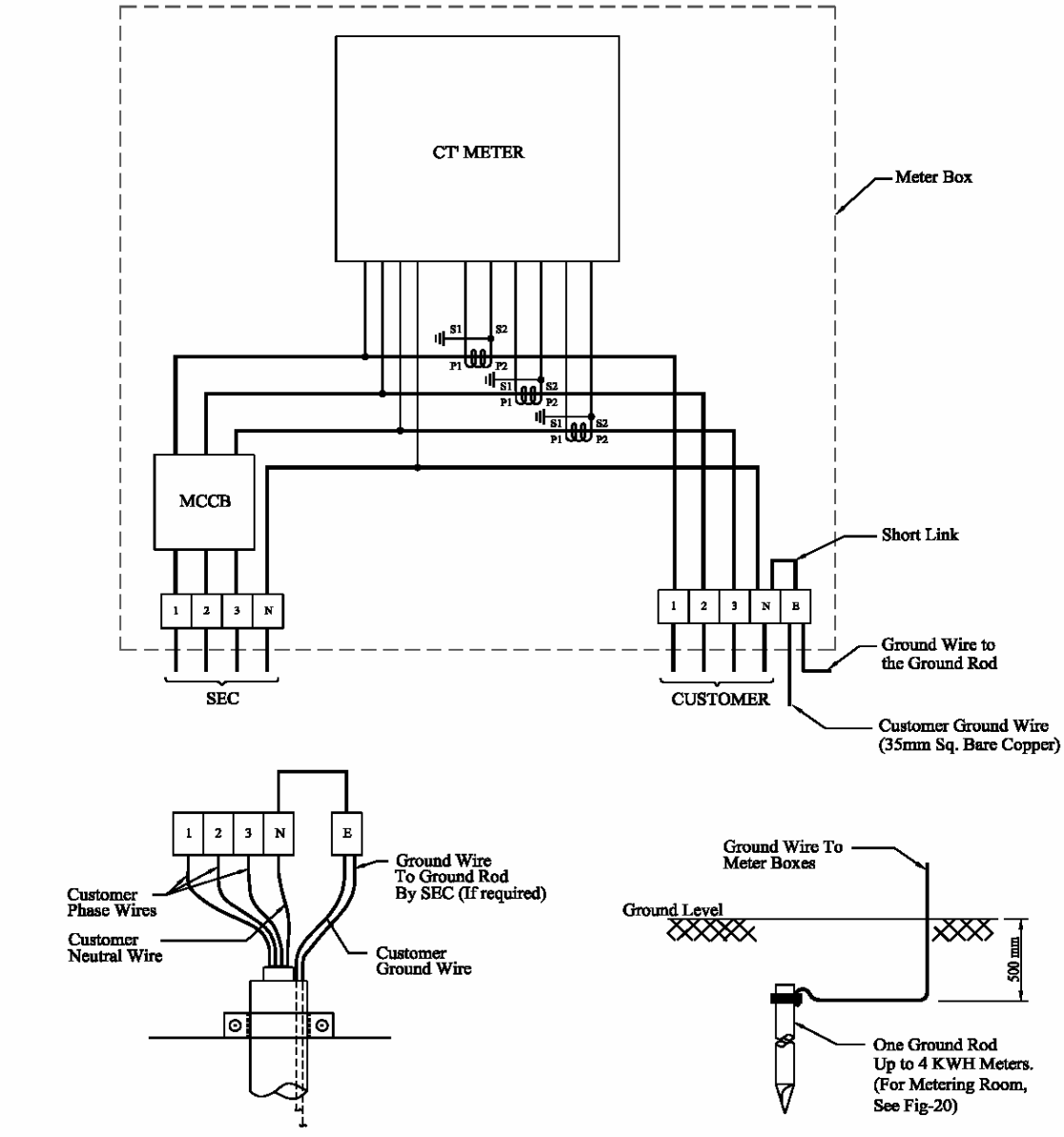


Fig-16 GROUNDING INSTALLATION OF CT METER UP TO 630A

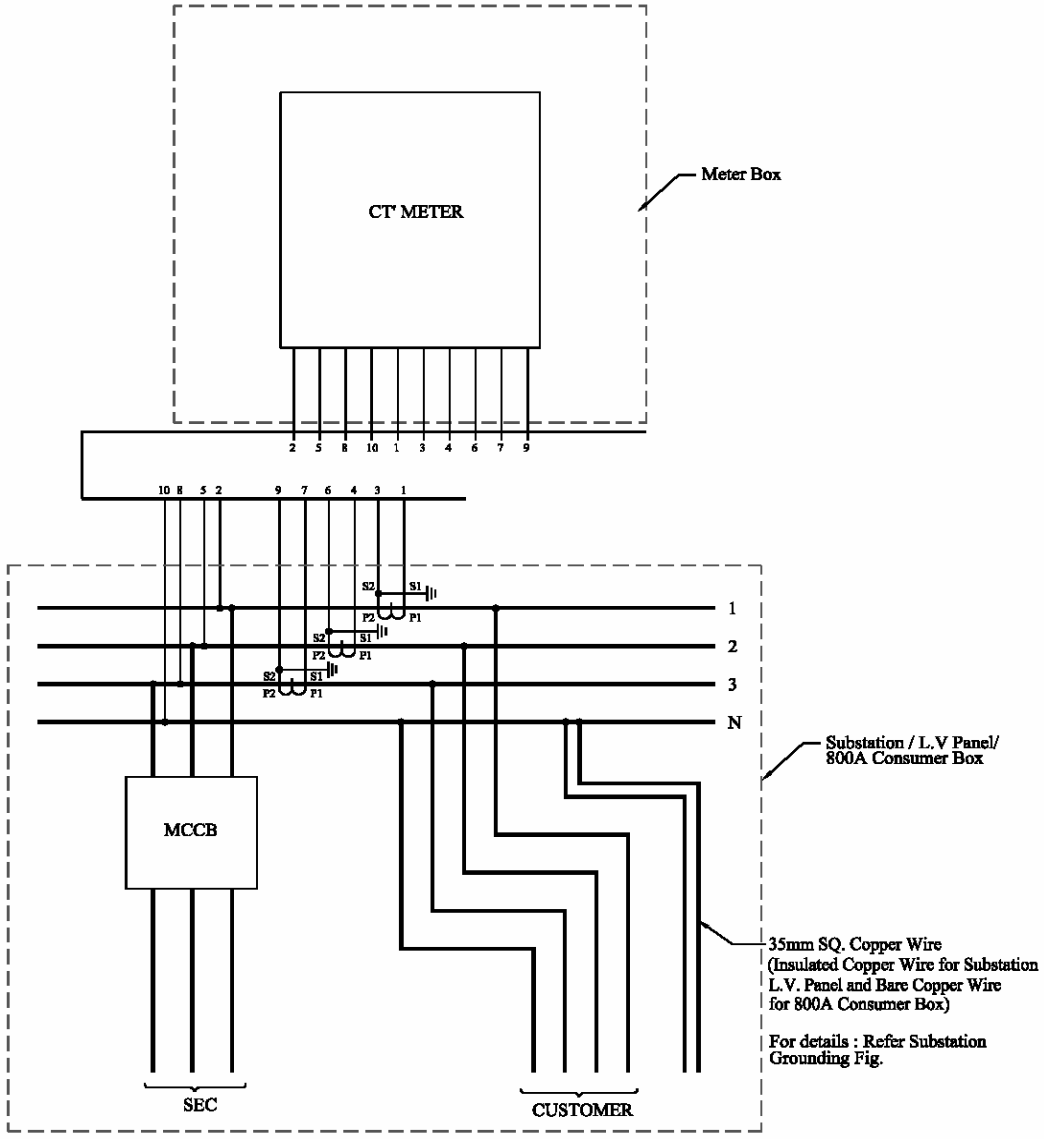


Fig-17 GROUNDING INSTALLATION OF REMOTE CT METER ABOVE 630A

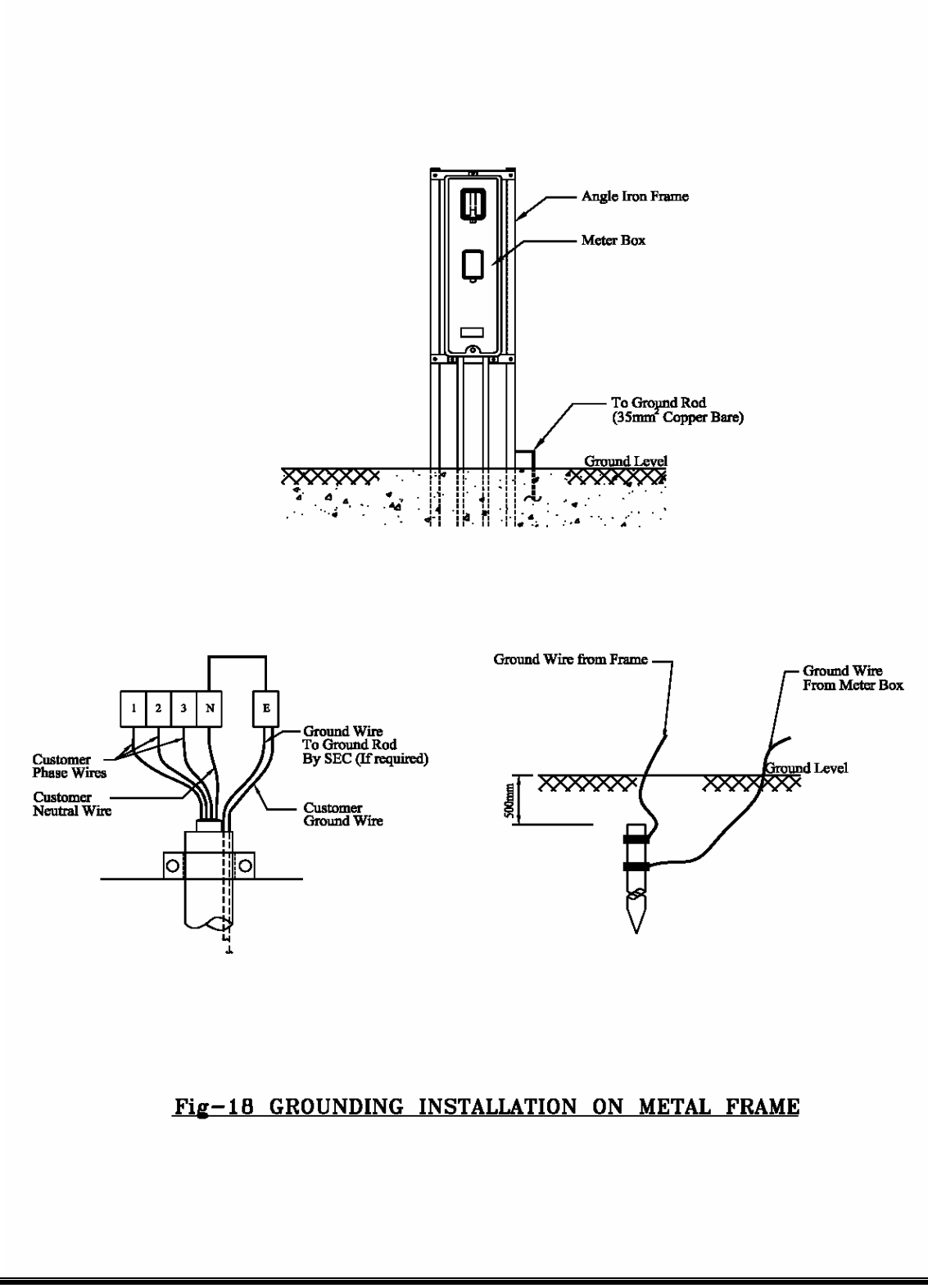


Fig-18 GROUNDING INSTALLATION ON METAL FRAME

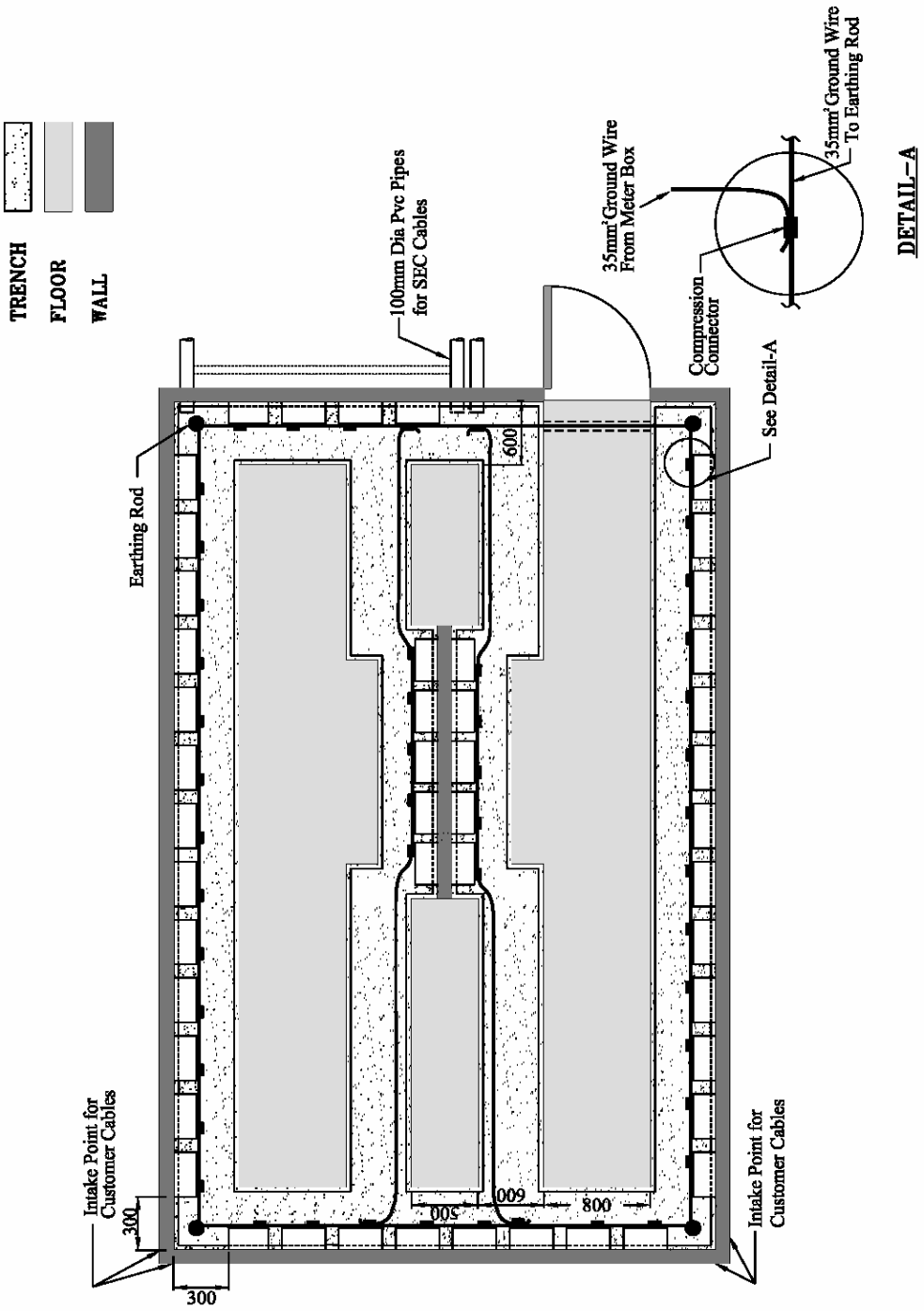


Fig-19 GROUNDING ARRANGEMENTS INSIDE METER ROOMS