CEEAMA
Consulting Electrical Engineers Association of Maharashtra

CEEAMA E-NEWS

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From the Editor's Desk,

The new year 2023 started off well with many news on health and economy fronts emerging very positive and encouraging.

Considering the fag end of the pandemic, we really hope that the Lockdowns would be now a matter of the past. People are coming out in large numbers whether for marriages, any small celebrations, World Cup Football, Cricket & Tennis matches, or visits to tourist destinations; all are at pre-covid levels now! More importantly the Industrial Exhibitions are getting overwhelming responses. The WFH (Work from Home) culture whether good or bad (let's debate that separately) has greatly taken a back-seat. This is quite encouraging!!!

The Global recession unfortunately doesn't seemed to have moved an inch. Add to that our "Rich Dad" Gautam Adani has been doing rounds after rounds in the News & social media due to the Hindenburg reports. This badly impacted bourses which otherwise were rock-solid. Hope this turbulence fades out soon!

As mentioned in the previous editorial, opening up of offices brought back jobs, more markedly for the Electrical Engineers. CEEAMA would like to bridge the aspirants with the Industry. Do contact us…

Our Finance Minister Ms. Nirmala Sitharaman has walked on a twin-edged sword by tabling the budget in the parliament. Kudos to her efforts, although wishing for acceptance of many improvements that will be suggested by the finance experts in the coming days.

We are Happy to announce the upcoming Technical program in April. It will be a joint program of CEEAMA and BAI Nagpur chapter on "Electrical Safety for High Rise Buildings". Our Hon. President & Secretary would be the respective speaker and co-ordinator. This will be our first program outside Mumbai/Pune/Kolhapur. Earnest request for your hearty support.

We are also glad to announce that our senior GC member Mr. Ulhas Vajre has added another feather in his cap by successfully passing the Chartered Electrical Safety Engineers 2022 exam as declared by CEI and Secretary IE&L Dept. Do join me in congratulating Vajre-sir!

We take social media news with caution and thus The Times of India publication had a special mention of our efforts by publishing my name as 'chain-breakers' of fake news.

Once again would like to appeal for article contributions: E-NEWS committee working on Themes for E-NEWS will finalize one per quarter; topic related to electrical design.

Last but not the least, we at CEEAMA, expect to raise some revenue through E-NEWS for sustainable existence. We request Associate members to come forward and contribute in the form of Advertisements. Also appeal all our members and readers to remain united and patronise with the association irrespective of your field of expertise and work.
Test

Regards,

Subhash L. Bahulekar
Chief Editor – CEEAMA

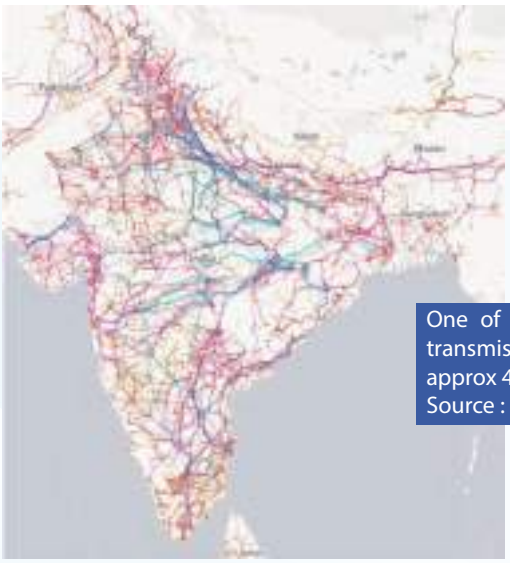
THIS MONTH

It's fake news, ₹1,000 notes not coming back from Feb 1

MEET FIVE OF THE CHAIN-BREAKERS

TIMES Verified

Congratulations Mr. Subhash Bahulekar for the mention in Times Of India - Article about social media fact verifiers.



One of the largest and most complex transmission networks in the world with approx 414858 circuit kms.
Source : Ministry of Power, Govt of India

CEEAMA running active campaigns on LinkedIn - Campaign started by Ganesh

CEEAMA Hon. President Mr. Narendra Duvedi felicitating a young officer from Mumbai Fire Department in FSAI Conference

EARTHING DESIGN & CALCULATIONS
Part - 2(a)

Earthing System For Large HV/EHV Substations

In continuation of the Part-1 of the article, we wish to bring you the second part of Earthing Design & Calculations. In this part we cover the large size HV / EHV substations. We are also including some aspects in response to some suggestions and comments by the readers. We express our gratitude to the readers who have taken time to express their views and offer suggestions. As stated in the previous issue we will be covering salient points without going in too many details. The reader can follow the references given to dwell deep into the subject.

1.0 General:

As suggested by a keen reader, some fundamental reasons for the earthing are given below.

- The earthing system provides a low resistance return path to facilitate satisfactory functioning of protective devices under fault conditions.
- For earth faults with return paths to offsite generation sources, a low resistance earthing grid relative to remote earth prevents dangerous ground potential rises (touch and step potentials).
- To ensure that all living beings in the vicinity of substations are not exposed to unsafe potentials under steady state or fault conditions.
- To retain system voltages within reasonable limits under fault conditions (such as lightning, switching surges or inadvertent contact with higher voltage systems), and ensure that insulation breakdown voltages are not exceeded.
- To provide 'Equipotential Bonding' that helps in preventing electrostatic buildup & discharge, which can cause sparks with enough energy to ignite flammable atmospheres.
- The earthing system provides a reference potential for electronic circuits and helps reduce electrical noise for electronic, instrumentation and communication systems.

2.0 Earthing System Overview For HV/EHV Substations:

The earthing calculations help in the proper design of the earthing system. The calculations are done to achieve the following:

Determine the minimum size of the earthing conductors required for the main earth grid.

Ensure that the earthing design is appropriate to prevent dangerous step and touch potentials.

This calculation is based primarily on the guidelines provided by IEEE Std-80 (2000), 'Guide for safety in AC substation grounding'.

2.1 Types of Earthing:

The earthing can be broadly divided into 'System Earthing' & 'Equipment Earthing'

System Earthing:

This is primarily concerned with the protection of Electrical equipment by stabilizing the voltage with respect to ground (Connection between part of plant in an operating system like LV neutral of a Power Transformer winding and earth).

For more information on System Earthing, section-6 of IS: 3043 may be referred.

Equipment Earthing (Safety Grounding)

This is primarily concerned with the protection of personnel from electric shock by maintaining the potential of non current carrying part of the equipment at or near ground potential. Connecting frames of equipment (like motor body, Transformer tank, Switchgear box, operating rods of air break switches, etc.) to earth.

For more information on Equipment Earthing, section-7 of IS: 3043 may be referred.

2.2 Types of Earth Electrodes:

Rod Electrodes
Pipe Electrodes
Plate Electrodes

For details of the above, Figures 14 & 15 of section-9 of IS: 3043 may be referred.

Typical required values of the minimum earth resistances are given below

Power Stations	0.5 Ω
HT/EHT Substation	1.0 Ω
Distribution Substation upto 33 kV	2.0 Ω
Tower Foot Resistance	10.0 Ω

2.3 Terms & Definitions:

Step Potential:

Step Potential is the difference in the voltage between two points which are one meter apart along the earth when ground currents are flowing (at the time of faults).

The shock arising out of this is typically a foot-to-foot shock which would involve the current going through one foot and then out from the other. This is typically caused by an increase in ground potential rise which allows current to build up on the soil surface and then through objects or persons on the surface such as a man standing or walking. The foot-to-foot shock is the least dangerous of the three because the current does not go through the vital organs such as the heart.

Touch Potential:

Touch Potential is the difference in voltage between the object touched and the ground point just below the person touching the object when ground currents are flowing.

The shock situation arising out of this is typically a hand-to-feet which involves touching something that is electrified with the hand and having the current pass into the ground through the feet.

Another shock situation is a hand-to-hand or metal-to-metal contact which would be touching something electrified with one hand and having the current go through the other hand that is touching something else. These shocks can usually be eliminated by connecting all the objects in the substation to the grounding grid.

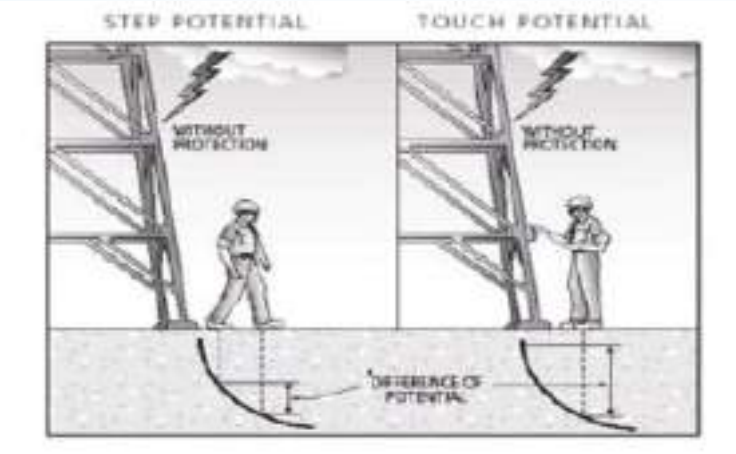


Figure-1, Step & Touch Potentials

(The Figure 1 of IS: 3043 also shows the different shock situations of Step & Touch Potential at the time of fault.)

Ground Potential Rise:

The maximum electrical potential that a sub-station grounding grid may attain relative to a distant grounding point assumed to be at the potential of remote earth. This voltage is equal to: GPR = $(I_G \times R_G)$

where, I_G = Maximum earth grid current

R_G= Earth Grid resistance ('Earth grid' i.e. Earthing system)

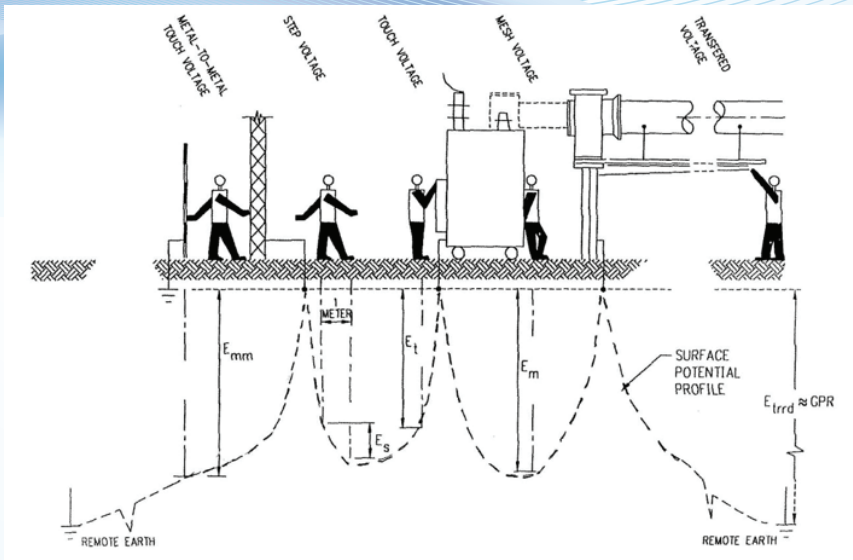


Figure-2, Basic Shock Situations & GPR

D. Mesh Potential:
The maximum touch potential within a mesh of the grid.

E. Transferred potential:
A special case of touch potential where a potential is transferred into or out of the substation from or to a remote point external to the substation site.
A person standing in a substation coming in contact with say rails/water pipeline/neutral coming from an adjacent substation at the time of occurrence of earth fault at that substation gets exposed to the transferred potential which equals difference in GPRs of the two substations.

2.4 Permissible Current Through a Human Body During the Fault
Humans are quite sensitive to AC currents ranging from 50-60 Hz. The effects of the AC current going through a human body depend on the magnitude, duration, and also frequency. The threshold of perception for the human body is about 1mA. Currents between 1-6 mA, often called let-go currents, usually do not impair a person from controlling his muscles and releasing the energized object they were holding. Higher currents ranging from 9-25 mA can cause pain and affect the muscle control so that the energized object is hard if not impossible to release. Still higher currents between 25-75 mA can affect breathing and may cause fatality. If current is even higher, it could result in ventricular fibrillation of the heart, which if not treated quickly, can result in death. When currents reach 100 mA and higher, above the ventricular fibrillation level, it can cause burns, heart paralysis, and inhibition of breathing.

2.5 Specification of Earthing
Depending on soil resistivity, the earth conductor shall be buried at the following depths.

Table 1

Sr. No.	Soil Resistivity in Ohm-Mtr	Economic Depth of Earthing Grid Burial in Mtrs.
1	50-100	0.5
2	100-400	1.0
3	400-1000	1.4

To keep the earth resistance as low as possible in order to achieve safe step and touch voltages, an earth mat shall be buried at the above depths below ground and the mat shall be provided with grounding rods at suitable points. All non-current carrying parts at the substation shall be connected to this grid so as to ensure that under fault conditions, none of these parts are at a higher potential than the grounding grid.
Here we have assumed the soil resistivity as 100 Ω-m and the depth of the grid as 0.6 metres. The proposed earthing mat is shown below in Figure-3.
Following points should be fallow to keep the earth resistance as low as possible.

- Remove Oxidation on joints and joints should be tightened.
- Pour sufficient water in earth electrode.
- Use bigger size of Earth Electrode.
- Electrodes should be connected in parallel.
- Earth pit of more depth, width & breadth should be made.

2.6 Earth Mat Design

Earthing system in a substation comprises of Earth Mat or Grid, Earth Electrodes, Earthing Conductor and Earth Connectors.

2.6.1 Earth Mat or Grid

Primary requirement of earthing is to have a low earth resistance. Substation involves many earthings through individual Electrodes, which will have fairly high resistance. But if these individual electrodes are inter linked inside the soil, it increases the area in contact with soil and creates number of parallel paths. Hence the value of the earth resistance in the interlinked state which is called combined earth value which will be much lower than the individual value.
The inter link is made through flat or rod conductor which is called as Earth Mat or Grid. It keeps the surface of substation equipment as nearly as absolute earth potential as possible. To achieve the primary requirement of earthing system, the Earth Mat should be designed properly by considering the safe limit of Step Potential, Touch Potential and Transfer Potential.

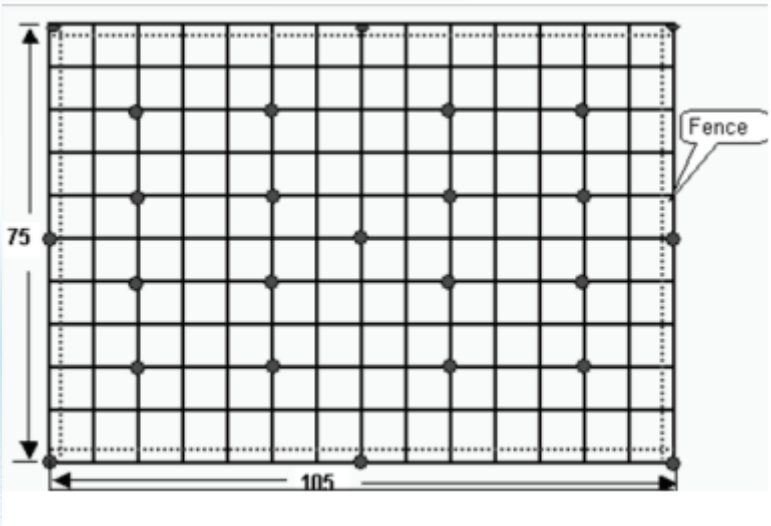


Figure-3, Proposed Configuration Of Earth Mat

2.6.2 The factors which influence the Earth Mat design are:

- Magnitude of Fault Current
- Duration of Fault
- Soil Resistivity
- Resistivity of Surface Material
- Shock Duration
- Material of Earth Mat Conductor

- Earthing Mat Geometry

2.6.3 The design parameters are :

- Size of Earth Grid Conductor
- Safe Step and Touch Potential
- Mesh Potential (Emesh)
- Grid configuration for safe operation
- Number of electrodes required

2.7 Surface Layer Materials:

The use of a thin layer (0.08m - 0.15m) of surface material such as gravel of high resistivity material around the substation can greatly reduce the chance and strength of electric shocks. The gravel can increase the resistance between the ground and a person thus making currents less likely to pass through them.

Table 7 of IEEE Std-80 gives typical values for surface layer material resistivity p_s in dry and wet conditions (e.g. 40mm crushed granite = 4000 Ω-m (dry) and 1200 Ω-m (wet).

Here, we assumed surface material of 100mm thickness and a resistivity p_s of 3000 Ω-m.

2.8 Methodology of Calculations: The stepwise method is given in the diagram.

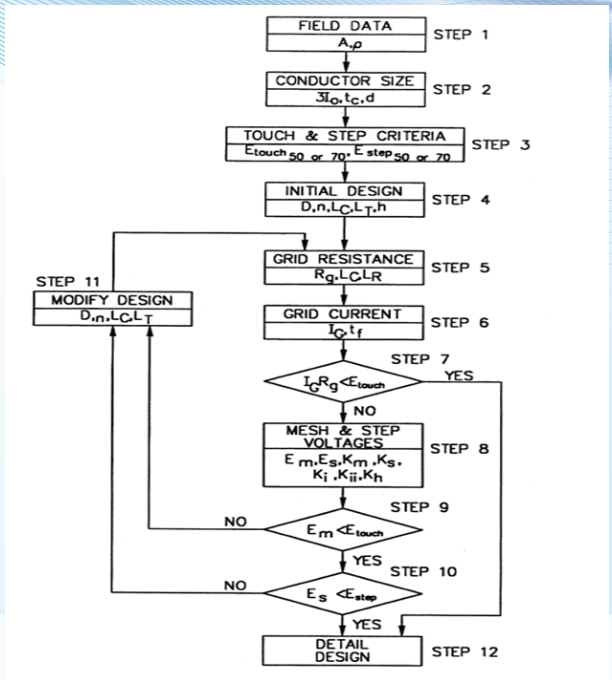


Figure-4

Special Note: If required, all the reference tables, formulae etc. can be made available to the readers from the draft copy of IEEE-80.

(continued & concluded in next E-NEWS as part 2(b))

References:

1. IS: 3043 - Code Of Practice For Earthing.
2. IEEE Std 80 (2000) - Guide for safety in AC substation grounding.
3. CBIP Publication No.223 – Design of Earthing Mat for HV Substations

Contributed by
LFM-049 Mr. Krishna Chandavar
K. S. Chandavar and Associates

CEEAMA E-QUIZ
JANUARY 2023

1. Instantaneous relay operates in
   a. 20-40ms
   b. 60-80ms
   c. Commissioning activities
   d. 1s

2. A galvanometer having the value of coil resistance is 120 Ω gives a full-scale deflection when a current of 3mA is passed through it. Find the value of the resistance, which can convert a galvanometer into an ammeter, giving a full-scale deflection for a current of 12 A.
   a. 0.07 Ω
   b. 0.09 Ω
   c. 0.11 Ω
   d. 0.03 Ω

3. Electrical DSM relates to
   a. Distant Summation Meter
   b. Demand Side Management
   c. Design Sizing Material
   d. Detail Study Method

4. The EnerGuide for Houses Program
   a. Demand Resource Management in India
   b. Baseload Reductions to Flexibility Provider – UAE
   c. Canadian Home Energy Rating System
   d. Initiative of ESCOs

5. Which of these is not DSM technique?
   a. Valley sinking
   b. Peak clipping
   c. Valley filling
   d. Load shifting

6. PDC split section depends upon
   a. Arc Vent location
   b. Panel arrangements
   c. Roof orientation
   d. All of the above

7. Constant Torque Load
   a. Centrifugal Fan
   b. High Speed Compressor
   c. Reciprocating compressor
   d. Blower

8. "Price-based" or "economic" DR usually involves voluntary customer participation
   a. TRUE
   b. FALSE

9. Financing is the Core Business of ESCO
   a. TRUE
   b. FALSE
   c. Can't say
   d. Not necessary

10. Sizing of capacitor depends upon
   a. Inductive Load
   b. Resistive Load
   c. Reactive Load
   d. All of the above

Rules for the QUIZ:

- The Quiz will be open for 10 days from the date of EMAIL.
- Each correct answer received on DAY 1 will get 100 points
- Next days the points will reduce as 90 – 80 – 70 and on 10th day points will be ZERO even if the answer is correct.
- All participants will receive E certificate signed by CEEAMA President with the points earned mentioned on the same.

Please use following google form link to participate in the QUIZ.
https://forms.gle/f7BpNdYVavD3pkxX6

"Thank you all for the overwhelming response to the E-NEWS in general and E-Quiz in particular. MCQ based quiz is always tricky and surprisingly can take us aback when we realise our conceptions (misconceptions) about the subject / system / product.

The aim of the feature was to create inquisitiveness in your mind and help you check your technical quotient quickly. The response will also help us to present articles and webinars on subjects which are important, but which lack enough awareness / knowledge in general.

It can open a pandora box for our discussions and arguments and probable solutions. Engineering evolves with conception. It gets fuelled with community discussions and capitalist actions. All stakeholders start realising the need to take a closer look and help improve standards as we have seen in the past century. Surely it makes the world a better place.

Wish you all a better luck this time.
Do spread the word.

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A-103. Sanpada Railway Station Building, 1st floor Sanpada East, Navi Mumbai – 400705
Email: admin@ceeama.org