

Application of Marconite as a Good Ground Enhancement Material than Bentonite in Transmission Lines- a Case Study.

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Abstract : The earthing system has an important role in safe operation of Transmission lines. In the hilly terrain / terrain of high soil resistivity or lightning prone areas, lightning over voltage causes flashovers and subsequent tripping in transmission lines. Reduction of grounding resistance is one of the efficient ways to prevent occurrence of such flashovers. The primary object of safe earthing design of a transmission line is to provide low resistance path to lightning current. 400 kV transmission lines of NETC traverses through areas having high soil resistivity (10–10,000 Ω m) and high isokeraunic levels, soil is very acidic in nature in addition to other severe environmental conditions of North Eastern Region. This paper presents a Case Study on the impact of high soil resistivity in lightning prone area and mitigation measures being adopted in 400KV D/C Silchar (Assam)-Byrnihat (Meghalaya) interstate transmission line of NETC by application of Bentonite & Marconite.

Keywords-TFR, Bentonite, Marconite, TLA, NETCL, Soil resistivity,

Introduction

North East Transmission Company Limited (NETC) is a Joint Venture Company of POWERGRID, OTPC and Six states of North Eastern region. The main objective of the company is to evacuate 726.6 MW power from Gas Based Combined Cycle Power Project (GBCCPP) of OTPC at Palatana in Tripura. NETC is operating 400kV D/C Palatana-Silchar-Bongaigaon transmission line of 662.8kM traversing through the states of Tripura, Meghalaya and Assam. One circuit of 400kV Silchar – Bongaigaon double circuit Interstate line is looped -in looped- out at Byrnihat substation in Meghalaya and another circuit is looped-in looped -out at Azara substation in Assam.

A.MAJORCONSTRAINTS IN OPERATION AND MAINTENANCE OF TRANSMISSION LINE IN NORTH EASTERN REGION:-

The Operation and maintenance of transmission line in North Eastern Region is a big challenge due to following major constraints

- i) Dense forest, Hilly terrain, fast growing vegetation, Agricultural Cultivation fire.
- ii) Frequent land sliding & road blockage due to heavy rainfall. The rain fall in NER is about 7-10 times more than all India average rainfall.
- iii) The acute ROW issues and theft prone area in some part of Assam, River scoring.
- iv) Severe lightning in some portion of line

B) To minimize the impact of lightning effect, following options were analyzed.

- i) Providing additional earthing of towers through PG clamp with separate earth pit.
- ii) Providing spike on tower top to capture lightning strikes.
- iii) Providing one more additional insulator disc to protect against Back flashover.
- iv) Installation of Transmission Line Arrestors (TLA) in location where TFR value is more than 50 ohms.
- v) If the value of the soil resistivity more than
 - i) 1500 ohms meter use of counter poise earthing up to 70 meters
 - ii) vi) The Use of Morolite (Mixture of Bentonite with 7.5% salt) with 40 mm dia Galvanized pipe type electrode.
 - i) vii) Addition of Salt & Charcoal with Rod earthing.

i) viii) Carbon earthing.
 B.1 Lightning is a massive electrostatic discharge caused by electric charges in the atmosphere and resulting in a strike from cloud to itself. Lightning is a very high frequency signal and high voltage /current, Impedance of the line change with the frequency of lightning, Whenever lightning strikes the top of a transmission tower or earth wire, a lightning current flow towards bottom of the tower and causes voltage rise to a tower which results in back flashover across the insulators of transmission line or causes phase to ground fault. The probability of flashovers can be

minimized if the lightning current gets the least resistance path to ground, which can be achieved by reducing TFR.

c) TYPES OF CHEMICAL EARTHING

Following type of Chemical earthing compound is commonly used for reducing the soil resistivity

a) Bentonite

b) Marconite.

Bentonite and Marconite have certain similarities and both are used as ground improvement materials (GIM) to reduce earth resistance. NETC considered Bentonite due to its cost effectiveness over Marconite for improvement of lightning performance of Transmission line. Bentonite and Marconite have certain similarities and both are used as ground improvement materials (GIM) to reduce earth resistance. NETC has first considered Bentonite due to its cost effectiveness over Marconite for improvement of lightning performance of Transmission line.

D) TYPES OF BENTONITE:

Two types of Bentonite is commonly available

1) Sodium Bentonite.

2) Calcium Bentonite

Sodium bentonite is having properties of swelling while calcium bentonite is non swelling in nature. NETC has used the sodium bentonite as it can absorb water up to 5 times of its original weight and swells up to 13 times of its dry volume in 139 tower locations.

E) BENTONITE CHARACTERISTICS.

Bentonite usually forms from weathering of volcanic ash with high content of silica. Swelling properties & moisture retaining properties. Bentonite clay is a natural earth soil (Clay) containing the mineral montmorillonite. Due to its high moisture characteristics, resistivity of soil decreases.

F) Marconite Characteristic and advantage over the Bentonite.

i) NETC is explored the alternate option to Bentonite earthing in some of the locations by using the Conductive concrete earthing (Cement by using the Ground Enhancement Material as a Marconite, After application obtained good result.

ii) The marconite is Corrosion & Maintenance free product.

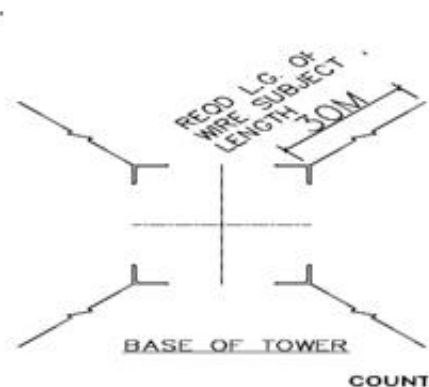
- iii) The life of the Marconite is 50 years as compared to the life of bentonite which is 4 to 5 years.
- iv) It is very low resistivity dissipate the fault current very fast.
- v) It did not leach away by ground water as a conductive concrete. Chemically inert,
- vi) Marconite did not require the water to flow of the electricity, as bentonite It conduct the electricity through the movement of the electrons. Its pollution free green product used by NETC as Innovative measure in T/L first time in India for Transmission lines.
- vii) The soil pollution has been reduced by the application of the marconite it don't requires water at regular interval so saving in the water resources.

The various power utilities /railways/companies are using Marconite in their substations and proved very effective .For earth pit don't requires the water periodically so its saving of water resources . Three types of earthing in T/L

- i) Pipe earthing and
- ii) Counter poise earthing.
- iii) Pipe Type Earthing.

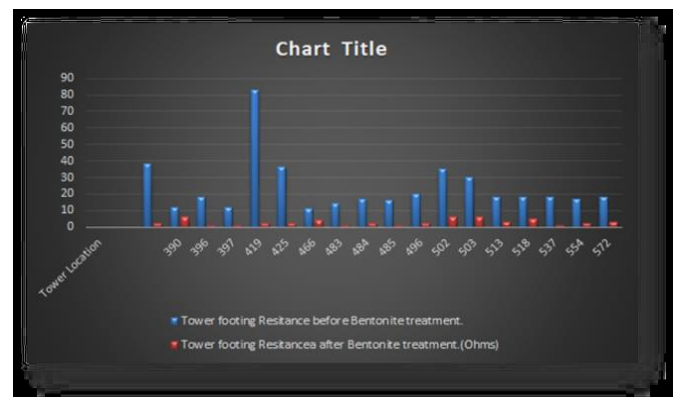
Bentonite treatment in counter poise earthing of transmission line of NETC

While implementing chemical earthing, sodium bentonite was laid at a depth of 900 mm using new galvanized steel stranded Wires(10.97mm) with proper compaction by means of ramming of soil after every 400 mm back filling. In each leg approximately 500Kg Sodium bentonite has been used. The length of galvanized steel wire was kept up to 40 meters depending upon soil characteristics.



BENTONITE APPLICATION WORK .

The Graph showing the improvement of TFR before and after Bentonite Treatment. (X- axis indicates tower locations & Y-axis indicates Resistance in OHMs)



E) Marconite Conductive Concrete Implementation :-

Marconite Earthing Execution:- The Marconite contain the fixed carbon (98.5%), by product of coal, very low resistivity of 0.001 ohms, after adding with water & cement it will be 0.19 ohms, The standard mixture ratio is 75 Kg marconite, 25Kg Cement, and 25 Kg/liter water. Marconite available in premix form also. Its very challenging job of earthing maintenance in existing system line , various ROW can be encounter during excavation work , but requires no outage. The Marconite has to comply test and follow the IEC62561-7 standard.

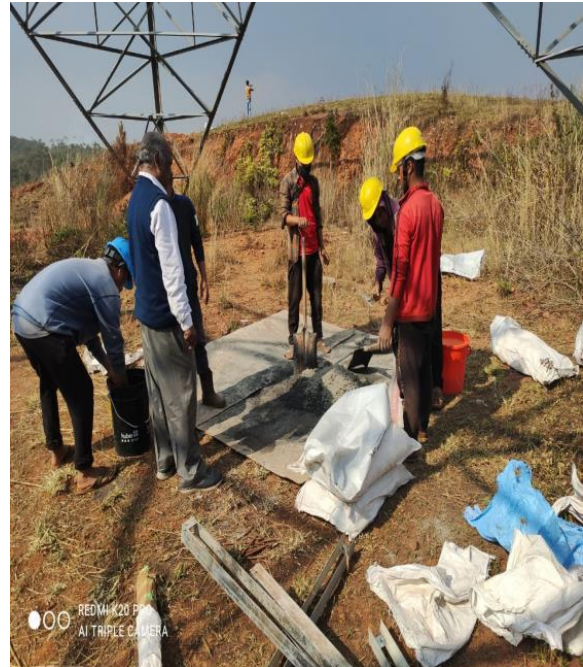
Procedure for Marconite application :-

Excavation of trench Length: 30 meters. Depth: 90 cms. Width: 30 cms. by manual means,

removal of existing counterpoise earth wire, cleaning and rubbing (if any rusting found) of counterpoise earth wire, application of bituminous paint on the surface of counterpoise earth wire. (anti corrosive paint), setting of form box for putting of counterpoise earth wire and mixture, back filling of the trench with excavated soil (without stone mixed soil) and ramming of soil after every 40 cms back filling.

Application of Marconite:

Mix Marconite with cement & water so as to form a mortar (Ratio of marconite: cement is 2:1). Pour the mixture inside the form box say 25 to 50 mm (1-2 inch) thick. Lay the counterpoise earth wire on top of the mixture inside the form box. Apply another layer of the mixture say 25 to 50 mm (1-2 inch) thick. Ensure that the counterpoise wire is fully covered. Wait till the mixture become set. Carefully remove the form box and backfill the trench with the excavated soil. Rammed the soil after every 40 cm to ensure that the soil is compact.



**MARCONITE EARTHING
EXECUTION WORK**



Improved results after application of the Marconite in :-

S. N	Tower Location	TFR average Value before application of Marconite. (Ohms)	TFR average Value after application of Marconite (Ohms)	Remark.
1	318	Infinity (Beyond the range of meter)	6.08	Value Improved.
2	319	much more value & Lightening mark observed in this locations.	5.18	Value Improved.

NETC successfully implemented the Pilot project of the Marconite earthing where the Tower footing value improved .In location where the TFR value not improved the value will be more

than 50 ohms the idea of installation of Transmission Line Arrestors (TLA) will be the good option.. TLAs are installed on the conductors, electrically in parallel to insulator strings. In the event of lightning, instead of back flash over across insulator string, TLA conducts and provide path to the lightning current towards phase conductors. It not only avoids flashover but prevents tripping in the transmission line. It is worth mentioning that application of TLA nullifies any impact of higher tower footing resistance.

CONCLUSION AND LESSONS LEARNT

Based on the above field experience , it can be concluded
 Performance of transmission line depends on the performance of the earthing. It is essential to reduce the tower footing resistance to minimise the tripping of line during fault condition & Lightning stroke on transmission line. This paper mainly aimed to discuss various measure to improve the Tower Footing Resistance by using Using Sodium Bentonite as a Ground Enhancement Material (GIM) & Marconite in 400 KV in Transmission lines for improving the tower footing resistance (TFR) However Marconite is better ground enhancement material than Bentonite.
 In lightning prone areas where reduction of tower footing resistance does not improve performance of transmission line, application of TLA may be better option to reduce the tripping's.

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About Author:-



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