
Protection of transmission line towers during landslides - A case study

Abstract –.

North East Transmission Company (NETC) is entrusted with construction and maintenance of its 662.8 Km, 400 kV Double Circuit transmission line in the difficult hilly & dense forest terrain in the states of Tripura, Meghalaya and Assam in the North Eastern Region (NER) of India. The terrain consists of various types of soils viz. laterite, alluvial, loamy, red soil etc. and is prone to sinking and landslides due to steep gradient and soil characteristics accompanied with heavy rains in NER. The transmission line route traverses through areas of high rainfall, wind zones of V & VI and high Isokeraunic level.

NETC is regularly facing the soil erosion /land slide issue in various tower locations of Pallatana -Silchar Line section. The deforestation due to development and various construction works coupled with incessant heavy rains of NER are some of the reasons behind such landslides.

This paper strives to describe various types of challenges being faced by NETC in operation and maintenance of the line with respect to landslides, sinking of hills, soil erosion etc. and the mitigation measures adopted by NETC like providing bamboo palisading, retaining wall, maintaining the natural vegetation and taking up plantation near tower foundations.

Keywords: Oil and Natural Gas Commission (ONGC), ONGC Tripura Power Company (OTPC), Tower Footing Resistance (TFR), Random Rubble Masonry (RRM), Emergency Restoration System (ERS), Reinforcement Cement Concrete (RCC), Isokeraunic level, North Eastern Region (NER), Palisading.

INTRODUCTION- NETC's Transmission Line

NETC's transmission line is evacuating almost one third of the power demand of the North Eastern Region of India along with exporting power to a neighboring country.

This 400 kV transmission line corridor has been envisaged to evacuate power from ONGC Tripura Power Company's (OTPC) Palatana Gas Based Combined Cycle Power Project of 2x 363.3 MW in Tripura state. NETC has constructed 662.8 km of 400 kV Palatana- Silchar- Bongaigaon Double circuit line as detailed below:

- i) 400 kV Pallatana- Silchar D/c line (247. 39 km)
- ii) 400 kV (First circuit of D/C) Silchar- Byrnihat line (214.41 km)
- iii) 400 kV (Second circuit of D/C) Silchar- Azara line (256.41 km)
- iv) 400 kV (First circuit of D/C) Azara - Bongaigaon line (159 km)
- v) 400 kV (Second circuit of D/C) Byrnihat-Bongaigaon line (201 km)

Challenges

The task of operating and maintaining the transmission line with 100% availability is a prime concern of the company. NETC is facing following major challenges in this regard:

- i) Vulnerability of line due to exposure of tower foundations because of landslides & excessive rainfall. The transmission line is traversing through the states of Assam and Meghalaya having highest rainfall to the tune of about 3 to 5 times the average rainfall in India. The average annual rainfall in India is 300- 650 millimetres, where as in NER the Average rainfall is 2500-3000mm.
- ii) Submergence of towers in low lying areas
- iii) Tower endangerment during high wind & cyclones and changing course of rivers
- iv) Outages due to severe lightning in hilly terrains with high soil resistivity
- v) Transient fault & safety threat due to fast growth of vegetation and bamboo trees on hillsides due to the climatic condition of NER and local tradition of subsequent burning of these vegetations under transmission lines
- vi) Impact on the life of transmission line and outages due to rapid industrial pollution.

In addition to the above mentioned environmental & climatic challenges as well as inhospitable terrain, there are several local & social challenges related to insurgency, theft, Right of Way etc.

The Landslides in Pallatana-Silchar 400 kV line section in the state of Tripura

The NETC inter-state transmission line is passing through dense forest and hillocks and small hilltops in Tripura where the rain induced landslide is a regular phenomenon especially during the onset of monsoon every year and it puts to risk the transmission line towers may result in outage of the transmission line.

In the years 2016, 2018 and 2020, the state of Tripura experienced unprecedented heavy monsoon with incessant rains in the month of June. The intensity of rain was so severe that within a time span of 7–10 days, the free flowing rain water caused very heavy landslides in the entire hilly stretch of the State resulting in number of road blockades in the Inter-State National Highway including some arterial roads. The road cutting work being carried out in small hilltops also contributed to the landslides and instability of the hill slopes. During the year 2016, the Pallatana-Silchar line which is passing through 73 km of Hilly Forest in the state of Tripura region experienced frequent earthquakes of High intensity and heavy monsoon with incessant rains which are not a normal phenomenon. During earthquake, the horizontal seismic forces had created voids in a soil strata due to which water seepage caused sinking of Land mass in this region.

Due to above landslide in the state of Tripura, 25 numbers of tower locations of Pallatana-Silchar section of the transmission line were badly affected and 14 numbers of tower locations became vulnerable.

Landslides are caused by disturbances in the natural stability of hill slopes and generally occur due to heavy rains, earthquakes, or local factors like deforestation, shifting cultivation or quarrying activities. The climate change impact also affects the weather pattern and landslide phenomenon.

Approach & Methodology: -Mitigations Measures adopted by NETC.

This line being the high-capacity line for evacuation of power from a 726.6 MW Generation Plant, any break down like tower collapse etc. would have caused outage of the Plant resulting in severe power crisis in the North Eastern Region. This emphasized immediate temporary measures to protect these vulnerable towers for providing minimum protection followed by permanent protection.

There are also various direct methods of preventing landslides; these include modifying slope geometry, using chemical agents to reinforce slope material, installing structures such as piles and retaining walls, grouting rock joints and fissures, diverting debris pathways, and rerouting surface and underwater drainage.

An expert committee of Site/Head office was constituted and committee visited all the locations. It observed that in most of the tower foundations were exposed. It recommended various measures to prevent the towers collapse. As an immediate measure, temporary protection was suggested followed by revetment protection as permanent solution. The slope protection study and survey conducted through survey expert to shift the 2 Nos tower locations and various Guying arrangement were provided to 400 kV Tower locations for the support. The proper drainage of water from the tower base ensured. The proper drainage of water from the tower base was also ensured.

Temporary Protection: -

As an immediate temporary measure to protect these vulnerable towers, bamboo palisade in multi steps was provided along with empty cement bags filled with earth providing minimum protection. Sufficient plantation was also done in the eroded sides of the locations to retain the soil. Temporary protection work includes the shifting of material at tower locations, supply of cement bags filled with soils, erection of Bamboo Basket/ Palisading work.

Bamboo anchors the soil with its spreading root system thus preventing landslides. Apart from this, bamboo is used as barrier against soil erosion and other environmental services such as protection of water sources through reforestation of watersheds. Bamboo is a fast-growing plant and its wide network of roots and rhizomes is highly effective in keeping a check on soil erosion by holding/binding the soil firmly, thereby preventing soil loss from ravines.



Figures for Temporary Protection Locations with Guying arrangement.

Permanent Protection: -

However, as the measures taken were temporary in nature to provide immediate protection, permanent protections measures were subsequently taken up. Random Rubble Masonry (RRM) walls were constructed in 10 (Ten) badly affected tower locations before the onset of next monsoon to provide permanent protection.

Retaining wall /Revetment walls helps to support hill Slopes and are designed to stop the active pressure of soil. The construction of Revetment/ RRM (Random Rubble Masonry) wall involves the earth work excavation by manual and mechanical means, head loading of requisite materials to tower locations, construction of temporary access roads to the tower locations, providing and laying in position Cement Concrete (1:2:4, 1 Cement, 2 Coarse sand, 4 graded stone aggregate 20 mm nominal size) and back-filling of available excavated earth. The work includes all necessary stone revetment, concreting, earth filling above ground level, providing suitable revetment or galvanized wire netting and meshing packed with boulders. Weep holes are provided to slop down to drain the water.



Figures for Revetment wall Locations with Guying arrangement



Photographs of Committee visit & Workman planting a tree near tower.

Further, to ensure stability of the slopes, more plantation work have been carried out in these locations which help in reducing soil erosion. For stability of soil, natural vegetation is provided by NETCL.

Conclusion

NETC has been successful in maintaining excellent availability of 99.95% of transmission corridor by adopting various innovative and sustainable mitigation measures. To protect the transmission towers subsequent to landslides, NETC has provided immediate temporary protection followed by the Permanent measure of Revetment wall/Toe wall/ RRM (Random Rubble Masonry) and was successful in avoiding tower collapses at 3-4 number of locations. Further, natural vegetation provided near tower footing area shall provide the slope protection as well as help in preservation of the environment as a sustainable measure. The line patrolling is being carried out regularly to check such vulnerable locations to ensure stability of tower foundations across the year in order to provide uninterrupted supply of power.

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Authors: - Snapshot



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