EE5200: Journal Paper Analysis.

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Article:

"Modelling of 132 kV Overhead Transmission Lines by Using ATP/EMTP for Shielding Failure Pattern Recognition" by Zawani, Junainah, Imran & Faizuhar Mohd.

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https://www.sciencedirect.com/science/article/pii/S1877705813001562

BACKGROUND

The authors start the article by introducing the phenomenon of Lightning Overvoltage and its prominence in designing Transmission Line Insulators. They have then briefly explained the possible types of lightning strike that may hit the Transmission Line and the resultant phenomena such as back flash over, shielding failure and importance of Critical Flashover Voltage (CFO) in designing Transmission Line Insulators.

A 132 kV Double Circuit Transmission Line in Malaysia has been considered for shielding failure studies. For modeling the Transmission Line in ATP, a seven tower base model with shield wires grounded at both ends has been used. The authors have then introduced the various line models which are available in ATP with Bergeron model being the time domain model best suited to the Malaysian Transmission Line System. They have then, in brief, explained the Bergeron model and stated its representation at the fundamental frequency.

MODEL

For modeling the Transmission Line Tower, the authors have considered the multistory tower model which has been developed by Masaru Ishii in 1991. As the model developed by Masaru Ishii bares relevance for a 500 kV Transmission System which has not been studied here, the authors have developed a distributed line model which has been proven to be relevant to the 132 kV Transmission Lines in Malaysia. This model has been explained with the help of pictorial representations. Accordingly, cross arms and insulators string design parameters to be considered for 132 kV Transmission Lines have been deduced.

The article moves forward with the use of Leader Progression Model in designing of Transmission Line Insulators and the concepts of corona inception, streamer propagation and leader propagation relevant to the flashover mechanism.

The authors have then addressed the most prominent part of any lightning study – modeling of a lightning source. The authors have used Heidler model of ATP to model a Lightning source which is represented by a Current Source with a resistance in parallel. The resistance represents the impedance of the Lightning path. The authors have then explained the lightning strike using graphical representation of the lightning strike waveform and have deduced the Heidler's function that represents the lightning current waveform.

Further, the concepts of Tower Surge Impedance and Tower Footing Resistance relevant to the cylindrical tower (Tower design considered for Transmission Line Tower Structure) and their prominence in Lightning Studies have been explained.

After covering the Transmission line modeling procedure with prominent parameter deduction required for modeling the simple distributed line model, ATP Simulations results have been documented by the authors. They have simulated a lightning strike of positive polarity with varying amplitude relevant to the lightning phenomenon observed in Malaysia (Lightning strikes of 20kA, 34.5kA, 50kA and 100kA have been simulated) and graphs of Voltage with respect to time have been plotted for each phase for all the lightning strike amplitudes.Shielding failure voltage across insulator strings of each phase have been measured and it has been observed that flashover occurs when BIL is equal or greater than CFO.

CONCLUSION

The authors have deduced from the simulation results that as the current due to lightning strike is injected from upper phase conductor to lower phase conductor, there is a decrease in the maximum induced voltages across the insulators of these phases. Also, they have deduced that the maximum induced voltage across the insulator strings of each phase increases with an increase in the magnitude of lightning strike current.

CRITICAL REVIEW AND ANALYSIS OF THE PAPER

While the authors have explained their modeling methodology and the deduced conclusion in the article, some inconsistencies in assumed modeling parameters may be observed. The authors while considering the multistory tower model for modeling initially state that this model is not relevant for low voltages. But they fail to explain the basis of this conclusion and subsequent use of distributed line model for their analysis. The authors mention that the Lightning strike impulse amplitudes that they have considered for simulations are relevant to the lightning phenomena observed in Malaysia. But they fail to provide evidence supporting this assertion. For simulation, the authors have injected Lightning Currents on the Middle tower (4^{th} Tower) of the 7 Tower Model. They fail to explain why they chose the middle tower and not any random or end towers for their study.