ANALYSIS OF CORONA DISCHARGE AND EARTH FAULT 0N 33KV OVERHEADLINE

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ABSTRACT

This paper presents the findings of the analysis of Corona discharge and Earth fault on 33kV overhead distribution line.

Two high voltage experiments have *been carried out to find out the influence of concrete covering on flashover and voltage and current variation along the pole. Possible solutions have been analyzed and presented.*

Suggestions have been as to how to avoid corona.

1. INTRODUCTION

Corona discharge and Earth faults are problems faced by the Lanka Electricity Company (LECO) on some 33 kV distribution lines in the Moratuwa area. The electricity supply and services to customers along Uyana Road comes under LECO. There are 13m concrete poles on which the 33kV overhead line runs at the top and the 11kv line few meters below. The low voltage distribution line runs under the 11kV line.

Especially in the months of July and August, near to almost all the poles, a hissing noise is heard during night. At some poles it was observed that Corona flashover occurred on the 33kV line. What is special here is that the flash over occurs not between the conductors, but between the middle line conductor and the pole top. Due to this flashover, the middle line insulator gets damage and has to be changed several times. One pole also got damaged at the top.

During this flashover, a significant current passes through the concrete pole and affects the low voltage distribution line. The unwanted voltage rise due to the passage of current through the pole affects the low voltage distribution line and causes damages to the consumers electrical equipment.

A main aim of this paper is to present the reasons for this flashover and to make suggestions to prevent or reduce this effect.

In the concrete poles, the cross arm of the 33kV overhead line is generally connected with the ground through green covered copper wire. However in some places somebody has snapped these wires to obtain the copper.

The fault current for 33kV overhead line has been determined considering two cases.

1. Copper wire is present between cross arm and ground.
2. No copper wire is present between cross arm and ground.

2. LOCATION OF DISTRIBUTION LINE

The identified places are located in the Moratuwa area and comes under the Colombo district. Of these, Uyana Road starts from the Galle Road close to the Moratuwa town and runs towards the sea. The overhead lines that run along Uyana Road have been taken in to consideration for the study. The location is very close to the sea (no more than 1km from the sea).

3. OBSERVATION OF CORONA

1. On almost all the poles along the Uyana road, the hissing noise was heard on the 33kV overhead line.
2. At certain poles only, it was observed that visual corona occurred and sometimes flashover on the 33kV overhead line. Generally not on all three conductors were involved but the middle conductor and pole top.

3.2 Damage observation

The following damages were observed in the flashover poles:

1. Insulator damage
2. Pole damage
3. Low voltage distribution line snapped
4. LV line supporter got damaged.

3.3 Disruptive voltage (E_0)

The disruptive voltage E_0.rms is the minimum phase to neutral voltage at which Corona occurs (hissing noise occurring voltage). This is given by

$$E_0.\text{rms} = 21.2\delta m_o r \ln (d/r) \text{ kV}.$$

To analyze the particular situation, it is necessary to introduce another correction factor for salt air condition and wind effect. With this correction, if E_0 reaches a value that is enough for visual corona inception, this corona could be seen along all three phases of the 33kV line. Sometimes during a particular period, flash could occur between conductors, but more often, not between lines between conductor and pole top. So it clearly indicates poles are playing major role in this problem.

3.4 Some past records

The following past records were taken from LECO Moratuwa area office for the line under consideration. They give information on the date, type of damage and pole number.

- 07:07:2000 – Insulator damage due to flashover on the pole 73/1/1
- 10:08:2001- Low voltage neutral wire snapped on the pole ALM81
- 23:08:2001- Insulator damage due to flashover on the pole ALM87
- 20:07:2003- Low voltage neutral wire snapped on the pole 73/1/1

3.5 The factors affecting the corona formation

1. Atmospheric condition – corona depends on it since it occurs mainly in July and August months.
2. Physical condition of the conductor – not a major factor. Corona is seen to occur only on middle conductor at the poles. If it is a major factor visual corona should occur on other conductors also.
3. Spacing between conductor – It is sufficient (1100mm)
4. Line voltage – it influences because observation was made on 33kVline.

3.6 Experiments carried out

Objective: To show influence of concrete covering on flashover.

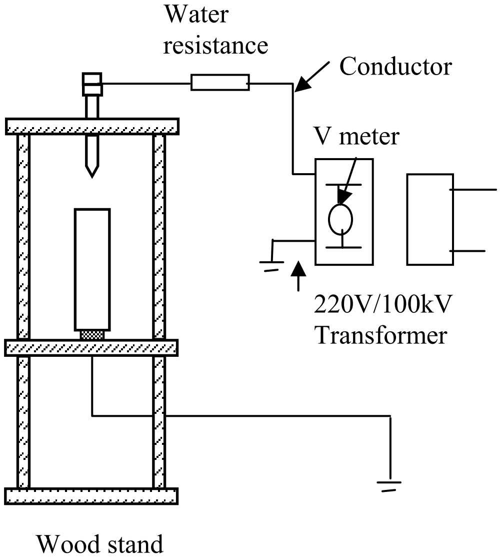

Fig 3.6 Equipment set up in the high voltage laboratory to observe the influence of concrete covering on flashover.

* The distance between reinforcement and electrode was kept as constant.
* Concrete covering thickness (x mm) above reinforcement was varied.

Secondary voltage (kV) = (100/220)*32 = 14.55kV

From the following table we can say when if the concrete covering thickness is high flashover voltage also high.

In 33kV line voltage is constant when concrete covering reduces it will easily lead to flashover

Thickness (X mm)	Voltmeter Reading (V)	Secondary Voltage (kV)
0	32	14.55
5	38	17.27
10	40	18.18

4. EARTH FAULT

The earth fault situation can be analyzed in two different manners. These are by considering

- Earth fault without earthing the cross arm by copper wire.
- Earth fault with earthing the cross arm by copper wire.

4.1 Earth fault without earthing the cross arm.

To identify the behavior of the earth fault without earthing the cross arm the following test was carried out in the field (figure 4.1).

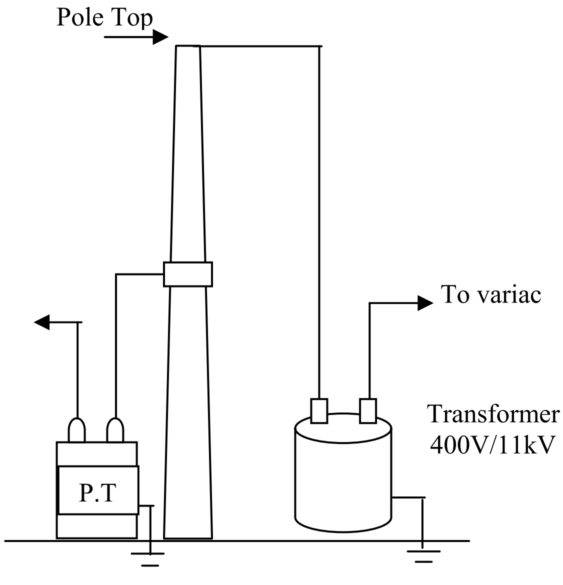

Fig. 4.1 Application of test voltage to pole

In this experiment, high voltage is applied to the pole top.

The voltage is gradually increased in six steps using an autotransformer. The voltage distribution along the pole was measured with the corresponding current.

4.11 Observations

* Voltage distribution is almost a constant along the pole 10m from the ground.

* Almost all the applied voltage appears on the top region of the pole.

* Concrete layer of the pole top burn out at the 840V.

Using above voltage distribution one can find out the pole impedance behavior at different voltages and this experiment reveals a equivalent model for a ideal reinforced pole.

Actually this situation can be nearly modeled as a single line to ground fault with an impedance (pole impedance) between the line and the ground. The relevant fault current is given by;

$$I_f = \frac{3E_f}{\{Z_1+Z_2+Z_0+3\,(Z_p+Z_e)\}}$$

Z_1: positive sequence impedance.
Z_2: negative sequence impedance.
Z_0: zero sequence impedance.
Z_p: pole impedance.
Z_e: impedance of the earth.

But the rather severe fault current occurs having with the earth wire.

4.2 Earth fault with earthing the cross arm.

This situation can be modeled as single line to ground fault. If we do not neglect the earth resistance, the fault current is given by,

$$I_f = \frac{3E_f}{(Z_1+Z_2+Z_0+3Z_e)}$$

In this case Pole impedance lies parallel with the earth wire and as it is very high compare with the resistance of the copper wire it can be neglected.

5. CONCLUSION

The major factor for the flashover is not sufficient thickness of the concrete covering. Experiment also clearly shows it. Following suggestion can be made to avoid it.

1. Special insulator (height is high) can be used which can increase clearance between conductor and pole top.

2. Clean the insulators frequently.

3. Keep better insulation covering between conductor and pole top.

4. Replace the poles.

In consumers point of view, we observed that electrical appliances like refrigerators, electric kettles, electric fans and trip switches have got damaged. This occurs during the time of flashover. If we avoid the flashover we can automatically correct it.

6. ACKNOWLEDGEMENT

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7. REFERENCE:

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