UNDERGROUND CABLE FAULT DETECTION

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Abstract— As India emerging as a developing country, civilized area is also increasing day by day, underground cables are best under such conditions its utilization is additionally growing due to its obvious advantages like lower transmission losses, lower maintenance cost and that they are less susceptible to the impacts of severe weather and so many. But it also having few disadvantages like expensive installation and detection of fault location. As it isn't visible it becomes difficult to seek out exact location of the fault. In this paper we will discuss the fault detection done in KCG.

I. INTRODUCTION

THE Power Transmission are often wiped out both overhead also as in underground cables. Unlike underground cables the overhead cables have the disadvantage of being easily susceptible to the consequences of rainfall, snow, thunder, lightning etc. This requires cables with reliability, increased safety, ruggedness and greater service.

Underground cables have been extensively used for power distribution networks over the years. This is because of their suitability for underground connections, better security from activities of vandals and thieves, and resistance to hazardous climatic conditions such as thunderstorms and whirlwind. They are cheap, easy to maintain and environmentally friendly. They have reduced maintenance and operating costs like lower storm restoration cost. Underground Cable also eliminate the menace of wind-related storm damage. They are not subjected to destruction caused by flooding which usually spoil and interrupt electric service. They ensure fewer transitory interruptions through tree falling on wires or electric poles falling down thereby improving public safety. Life-wire contact injuries is drastically reduced. It results in the elimination of unattractive poles and wires on the streets thereby enhancing the visibility of the drivers and pedestrians on the streets.

To lessen the threat posed by environmental impacts on the sensitive distribution networks, the underground high voltage cables are increasingly used. Despite these advantages, locating faults in underground cables are often a really cumbersome task. It is therefore very necessary to develop very efficient technique for detecting faults in these cables. There is various process taken before locating a fault in a cable. The Cable route are mostly known by the concern Electrical team working the organization. However, in some situation they don't have such a map so there is also a need for locating the cable at first then their details. The underground cable system is very useful for distribution mainly in metropolitan cities, airport and defence services.

II. LITERATURE SURVEY

Abhay Sharma, Akash Mathur, Rajat Gupta, Ranjeet Singh, Er. Mansi Singh in "Underground Cable Fault Distance Locator".

- This paper describes the fault detection using PIC16F887 Microcontroller which detects fault occurrence in an Underground cable used.

Abdulkadir Hamidu Alkali, Emmanuel Gbenga Dada, Stephen Bassi Joseph in "Design and Implementation of Underground Cable Fault Detector".

- This paper specifies the method by which the Underground cable's fault can be identified using the AT mega 328p microcontroller which is much easy and useful way to find the fault in an underground cable for a low rated cable.

Sahana S, Harish Kumar B M, Anu S M Vani H V, Sudha T, Prashanth Kumar H K in "Analysis of fault detection and its location using microcontroller for underground cables"

- The way by which the fault occurrence can be detected and the exact location of the fault can be identified using an Arduino controller which is Open source microcontroller board. It is designed to achieve monitoring of underground cable and to provide information about detected fault. The various conditions like over voltage, under voltage, short circuit and open circuit are monitored by respective sensors. If any faults occur that will be detected by respective sensors and sends that signal to controller via Monostable Multi-vibrators and interfacing stage i.e. buffer, driver and relay unit.

III. CABLES TYPES AND TYPE OF FAULTS

The assembly of one or many wire sides to side or bundled which carry the electric current is said to be a cable. The Cables are classified based on the voltage they operate and based on their construction. On the basis of voltage, the cables are classified as

- ✓ Low-Tension Cables (up to 1000V)
- ✓ High Tension Cables (above 1000V to 11KV)
- ✓ Super Tension Cables (above 11KV to 33KV)
- ✓ Extra High voltage Cables (above 33KV to 66KV)
- ✓ Extra Super voltage Cables (above 66KV)

On the basis of construction of the Cables are classified as

- ✓ Belted Cable (up to 22 kV),
- ✓ Screened Cables (from 22 kV to 66 kV),
- ✓ Pressure Cables (beyond 66 kV).

Screened Cables are further classified as

- ✓ H type Cable
- ✓ L type Cable

The pressure Cable is divided into two as

- ✓ Oil filled cable
- ✓ Gas pressure cables.

The fault in an any system is unpredictable. The detection of fault in an underground cable is very difficult task. The fault that in an underground cable's are listed below,

- Low resistance Faults or Short Circuit Faults
- Earth Faults or Ground Faults
- Open Circuit faults
- Cable break faults (due to Mechanical issues)
- Intermittent Faults
- Sheath faults

IV. CABLE LAYOUT

The cable laying method plays an important role in the power transmission through the cables. There are mainly three laying methods, they are Direct Laying Method, Draw in System of laying and Solid System of Laying.

A. DIRECT LAYING:

This is the basic method of laying the cables. A trench of 1.5 m depth and 45 cm wide is dug and covered with 10 cm thick layer of sand. After the layer of sand, the Underground cables is laid. Over this Underground cable another 10 cm of thick layer of sand is covered. For a multi-cable laying, 30 cm of sand is covered to reduce heating. Later the trench is covered by brick and soil.

B. DRAW-IN SYSTEM LAYING:

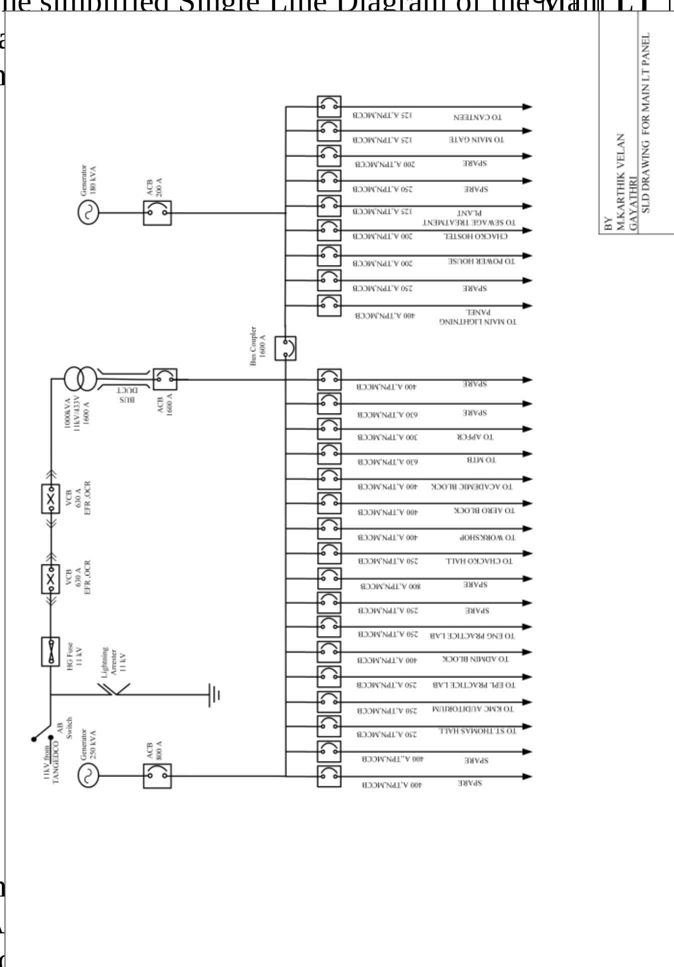
In this method, a duct of concrete is laid in ground with main holes at suitable positions along the cable route. Cables are later pulled from the main holes. In this system the Mechanical faults are reduced to much extend.

C. *SOLID SYSTEM LAYING*:

Cable are laid in open pipes or through a dug out in earth along the cable route.

V. CABLE LAYOUT IN KCG

To study the Electrical power cable layout and in-depth details of them lively we took the Electrical system used in KCG College of Technology situated in Chennai. The KCG is powered from TANGENCO. The incoming is protected by VCB (Vacuum Circuit Breaker), one at the TANGENCO incoming and another near a step-down transformer. The simplified Single Line Diagram of the Main LT pa[illegible] th[illegible]



th[illegible] A[illegible] vo[illegible] cables used are 3.5 core Polycab 440 V Aluminum Armoured Cables.

There are 27 feeders available in the KCG. This feeder uses 3.5 Core type cable insulated by PVC (Poly Vinyl Chloride) or by XLPE (Cross Linked Poly Ethelene). The cable size is chosen based on the need of load that specific feeder. The feeder detail as follow given in the table.

S.No.						Cable Current rating
1	[illegible]					
2	[illegible]					435 A
3	[illegible]					435 A
4	Acade[illegible]					285 A
5	[illegible]					435 A
6	Workshop	1	3.5 C	400 Sq	CCB	435 A
7	Chacko Hall	1	3.5 C	185 Sq	CCB	285 A
8	Spare				CCB	
9	Spare				CCB	
10	Admin Block	1	3.5 C	185 Sq	CCB	285 A
11	Spare				CCB	
12	Spare				CCB	
13	Spare				CCB	
14	Spare				CCB	
15	St Thomas Hall	1	3.5 C	150 Sq	CCB	255 A
16	KMC Auditorium	1	3.5 C	185 Sq	CCB	285 A
17	EPL parctice lab	1	3.5 C	120 Sq	CCB	225 A
18	Main Lightning Panel	1	3.5 C	400 Sq	CCB	435 A
19	Spare				CCB	
20	Power House (FF)	1	3.5 C	25 Sq	CCB	95 A
21	Chacko Hostel	1	3.5 C	70 Sq	CCB	170 A
22	Dummy					
23	Spare				CCB	
24	Spare				CCB	
25	Main Gate	1	3.5 C	50 Sq	CCB	140 A
26	Sewage Treatment Plant (STP)	1	3.5 C	50 Sq	CCB	140 A
27	Canteen	1	3.5 C	35 Sq	CCB	116 A

VI. FAULT DETECTION IN KCG

Sewage treatment plant of KCG acts as a separate feeder. A 50 Sqmm 3.5 Core Aluminum Armoured XLPE insulated cable. The length of the cable is approximately 400 meters. The manufacture of the cable is POLYCAB cable and wires Pvt Ltd. The fault analysis was carried out in this feeder cable.

Initially, to find the faulty core the Insulation

Resistance Test was used. The basic test is the Insulation resistance is done.

The following is the reading obtained for the IR test.

S.No.	Parameters	Set Voltage	Injected Voltage	IR value	Remarks
1	N-R Ph	500 V	47 V	9 k ohm	Not Ok
2	N-Y Ph	500 V	64 V	12 kohm	Not Ok
3	N-B Ph	500 V	300 V	58 kohm	Not Ok
4	R Ph- Y Ph	500 V	292 V	56 kohm	Not Ok
5	R Ph- B Ph	500 V	332 V	119 kohm	Not Ok
6	Y Ph- B Ph	500 V	352 V	65 kohm	Not Ok

Next to the Insulation Resistance test the Continuity test were carried out between the cores. The continuity test was done between all the cores and it is found that there is fault with Y phase since we didn't get the continuity.

Next to the Continuity test the Pre-location of fault was carried by Time Domain Reflectometer. The settings used for the test are given below.

Settings of TDR 410:
Velocity propagation – 81m/µs
Impedance Z-50 ohm
Gain Selection-Default

Fault pre-location:

The total length of the cable approximately 400 m and we have set right the v/2 value as 81 m/µs, also it's a XLPE cable as per table 2, the value should be 78 m/µs to 87 m/µs.

Thus, we have connected the TDR 410 between R phase and Y phase and we found the short circuit fault at 73 m in a 400 m Cable.

X. CONCLUSION

Thus, the cable audit completed successfully. The cable laying mechanism also plays a major role in the Cable health condition.

It is found that all the three phase R, Y, B have a fault in a STP feeder cable of XLPE insulation of 400 m and the fault of the cable was found at a distance 73 m in 400 m cable

It is suggested that the B phase and N can be used as a single-phase supply for a temporary need since B phase can handle voltage up to 330V as seen in the audit report while other two phases are unhealthy even for a single-phase usage.

It is suggested to change the method of cable laying to Draw-in method for better life and to reduce the fault occurrence in the cable since the location of the College near the water areas. The better adaptable cable laying methods usage will reduce the cable fault occurrence in the Underground cable.

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Cable Type	Velocity Propagation V/2, m/µs
PILC dry	75 - 85
PILC wet	108 - 132
XLPE	78 - 87
PE	approx. 100
PVC	76 - 87
EPR	68 - 83

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