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H04C0a - Finite Elements for Electromagnetic Fields: Exercises

Cable characteristics

Group 30

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1 Submarine cable and its characteristics

The cable we choose to study is a submarine cable. The cable conductors consist of aluminium (Al) and the insulation material is cross-linked polyethene (XLPE). Our cable is a common three-core XLPE separate lead (SL), sheath type submarine cable [1]. The cable is represented in Figure 1 and the different layer thickness and materials are given in Table 1.

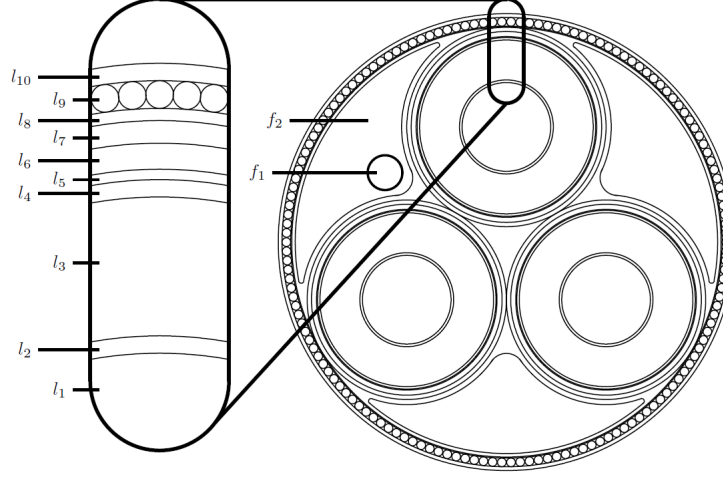


Figure 1: Construction of the cable [1].

Index	Layer name	Thickness t [mm]	Material
l1	Conductor diameter	16.9	Al
l2	Conductor screen	1.40	XLPE
l3	Insulation	9.00	XLPE
l4	Insulation screen	1.40	XLPE
l5	Swelling tape	0.60	PE
l6	Metallic sheath/screen	2.30	Pb
l7	Anti-corrosion sheath	2.50	PE
l8	Bedding	3.00	PE
l9	Armour	5.00	Steel
l10	Outer serving	4.00	PP

Table 1: Cable layer thickness and material [1]

The outer diameter is 134.5 mm. The element f1 is the optical fibre used for communication but will not be considered in our study. f2 represent the fillers and is usually filled with water in operation. The properties of the different materials composing the cable are summarized in Table 2. The cable is placed at a depth of 2m under the ground, in the seabed. The three-phase voltages and currents are balanced at frequency $f = 50$ Hz.

The different properties are taken from [2]-[5].

Additional study

As additional study, we will investigate the case where the cable is deposited on the sand and not buried.

Material	ϵ_r	μ_r	σ [S/m]	κ [W/(m K)]
Steel	1	4	4.7e6	50.2
Aluminum (Al)	1	1	3.77e7	237
Lead (Pb)	15	1	4.87e6	33
Polyethylene (PE)	2.25	1	1.0e-18	0.46
Polypropylene (PP)	2.2	1	6.25e-15	0.10
XLPE	2.5	1	1.0e-18	0.46
Seabed	30	1	1.5	2
Seawater	81	1	4	0.593
Air	1	1	3.33e-6	0.025

Table 2: Cable material properties

References

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