JKAU: Eng. Sci., vol. 9, pp. 23-40 (1417 A.H./1997 A.D.)

Experimental Study for Drying-out of Soil Around Underground Power Cables

O.E. GOUDA*, A.M. ABDEL-AZIZ**, R.A. REFAIE** and Z. MATTER**
*Electrical and Machine Dept., Cairo University, Giza,
**Electrical Eng. Dept., Al-Azhar University, Cairo, Egypt

ABSTRACT. Six types of soil were investigated for studying the drying-out phenomenon and the thermal behaviour of the soil around high power cables. Specific gravity, grain size distribution, permeability and compaction tests were carried out for six types of soil. The measured pF-curves and the recorded distributions of temperature with both time and distance at the stated conditions are presented. Also, the distributions of moisture with distance are given. From the analysis of the temperature distributions with both time and distance; it was found that the temperatures of some soil points are rapidly increased. From the analysis of the measured distributions of moisture with distance, it was also found that all soil points of rapidly increased temperature had approximately zero moisture content. So, the discontinuity found at the measured temperature distributions curves indicated the separation between two zones with high respectively low thermal resistivities or with dry respectively moist soil. Drying-out phenomenon started at 54°C in sand 2 and at 57°C in sands 1 and 3. During heating processes, it was noticed that some types of sand lose their moisture content faster than other sand types.

According to the field study of the thermal behaviour of the soil around buried cables, the soil drying-out was found during July and August. This was due to the heat emanating from the cables. This period of year was characterized by a high ambient temperature and zero annual rainfall.

KEY WORDS. Underground cable, Moisture migration, Drying-out zone, Soil thermal resistivity, Thermal behaviour of soil.

1. Introduction

The current carrying capacity of a buried high voltage power cable depends on cable surface temperature, thermal resistances of different cable layers and the thermal properties of the surrounding soil. Due to the heat emanated from buried cables, soil moisture migrates away from the cable leading to the increase of surrounding soil thermal resistivity[1,2,3]. After long operation for several years, the dried out zones are formed around the cable. These zones may lead to cable failure and thermal instability of the soil around the cable. Consequently, the ability of the soil to dissipate heat is much decreased. Soil thermal resistivity (STR) is determined mainly by the specific soil properties, degree of compaction, and moisture content[4,5,6]. On the other hand, the factors influence the STR are: Soil composition, dry density, gradation, water content, compaction and temperature[7].

Heat is conducted through moisture migration, grains and the water bridges around the places of contact[1-6,8,9]. The problem of coupled heat and water flows around buried cables was investigated by some authors[1,4,8]. The authors used Philip and De Vries theory[10]. On the other hand, the characteristics of soil affecting cable ratings were investigated[2-7,11,12].

The formation of a dry zone, due to moisture migration resulting from cable losses, leads to a marked decrease in the ability of soil to dissipate heat. Consequently, cable surface temperature rises continuously which leads to a thermal breakdown in cable insulation. Here, it should be noted that the cable current rating decreases by about 29% of its rating when the drying-out occurs[13].

For safe operation of buried cables, bedding soils such as sand are used to reduce soil thermal resistivity and to minimize moisture migration[2]. For maximum heat transfer the backfill soil around the cable should be well graded, having higher ratio of loam content and be compacted at optimum water content for maximum dry density[7].

In this paper, six types of soil were investigated for studying the drying-out phenomenon and the thermal behaviour of the soil around power cables. These types of soil are: Sand 1 (Giza zone), sands 2 and 3 (Nasr city zone), sand 4 (south Sinai zone), silty sand (Cairo zone), and silty clay (Delta zone). Specific gravity test, grain size distribution using sieves or hydrometer tests, permeability as well as compaction tests were carried out for them. Another two tests were done for sand 1, sand 2 and sand 3 (in which it is expected that the heat transfer is to be maximized) which are :

a) Water retention capacity (pF-curve) by means of gravity.
b) Thermal test for studying the drying-out phenomenon and the resulting distribution of: Temperature with both time and distance as well as moisture with distance.

For investigating the thermal behaviour of the soil around high voltage power cables, field experiment was carried out in Cairo zone, with cables laid in silty sand soil. The period at which drying-out could be developed is outlined later.

2. Experimental Procedure and Results

2.1 Specific Gravity Test

The specific gravity is used in the computations of void ratio, grain size distribution determined from hydrometer test and soil density. The specific gravity (G_s) is determined according to the formula[14,15]

$$G_s = \frac{W_s}{W_1 + W_s - W_2} \tag{1}$$

where,

W_s = Weight of dry soil (Kg),

W_1 = Weight of bottle filled with water (Kg) and,

W_2 = Weight of bottle filled with water plus soil (Kg)

The specific gravity values determined according to[14,15] for various soils tested are listed in Table 1.

TABLE 1. Values of specific gravity for investigated soil types.

Soil type	Sand 1	Sand 2	Sand 3	Sand 4	Silty sand	Silty clay
G_s	2.63	2.65	2.67	2.65	2.7	2.73

According to Table 1, the values of G_s are approximately constant.

2.2 Grain Size Analysis

Grain size analysis means the determination of various size of particles within the soil. The grain size distribution for all investigated soils was determined through mechanical sieve analysis[14,15] or hydrometer procedure according to the soil type. Figure 1 shows the grain size distribution for different soil types under investigation. According to Fig. 1 these soil types can be classified in composition as in Table 2.

2.3 Compaction Test

The purpose of compaction test[14,15] is to determine the relation between soil dry density (ρ_d) and moisture content (θ) in order to know the maximum soil dry density and the optimum moisture content. This relation can be computed from

$$\rho_d = \frac{\rho_s}{1 + \theta} \tag{2}$$

where,

ρ_d = Soil dry density (Kg/m^3),

ρ_s = Soil wet density (Kg/m^3) and

θ = Soil moisture content (m^3/m^3).

Figure 2 shows the soil dry density against soil moisture content for types of soil

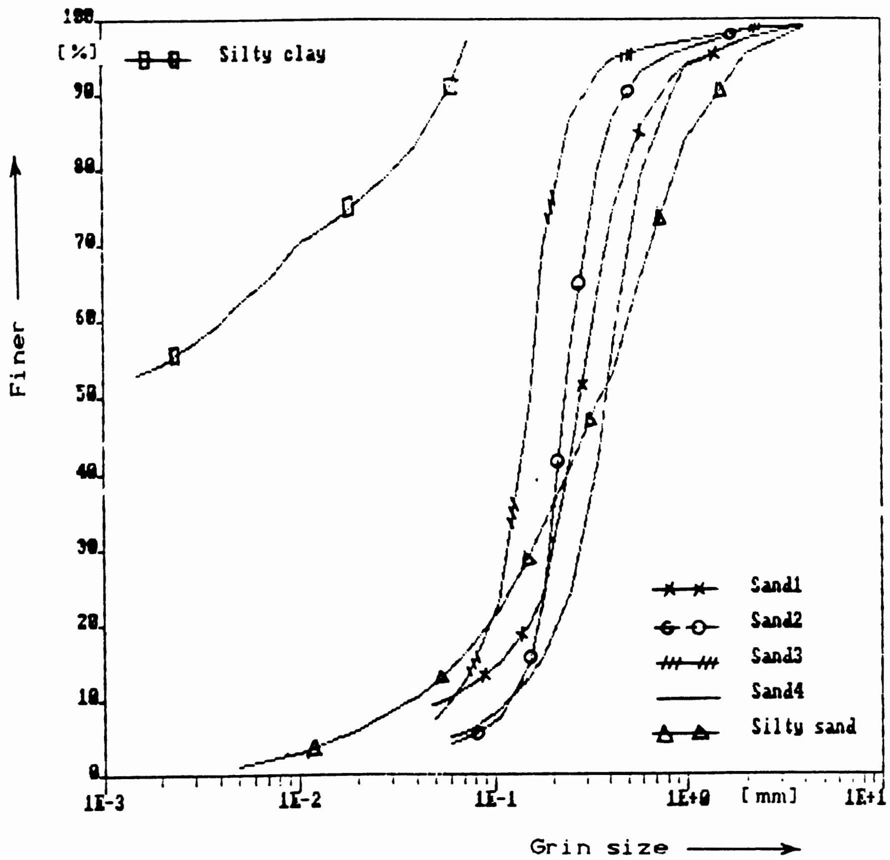

FIG. 1. Grain'size distributions for all investigated types of soil.

TABLE 2. Classification for investigated soil types.

Soil type	Weight percentage				Classification
	Gravel	Sand	Loam	Clay	
Sand 1	1.5	88.5	10	–	Coarse sand, poor in gravel, slightly loamy
Sand 2	2.0	94.0	4.0	–	Moderately coarse sand, poor in gravel, very poor in loam
Sand 3	2.0	88.5	9.5	–	Moderately fine sand, poor in gravel, slightly loamy.
Sand 4	2.5	92.5	5	–	Very coarse sand, poor in gravel, very poor in loam.
Silty sand	4.5	81.5	14	–	Very coarse sand, rich in gravel, slightly loamy
Silty clay	–	11	96	59	Poor in sand, slightly loamy, very rich in clay

under investigation. Maximum proctor density is related to soil gradation and to the loam content. In Table 3 the values of maximum dry density (ρ_d)$_{max}$ and optimum moisture content θ_{opt} for the investigated types of soil are given.

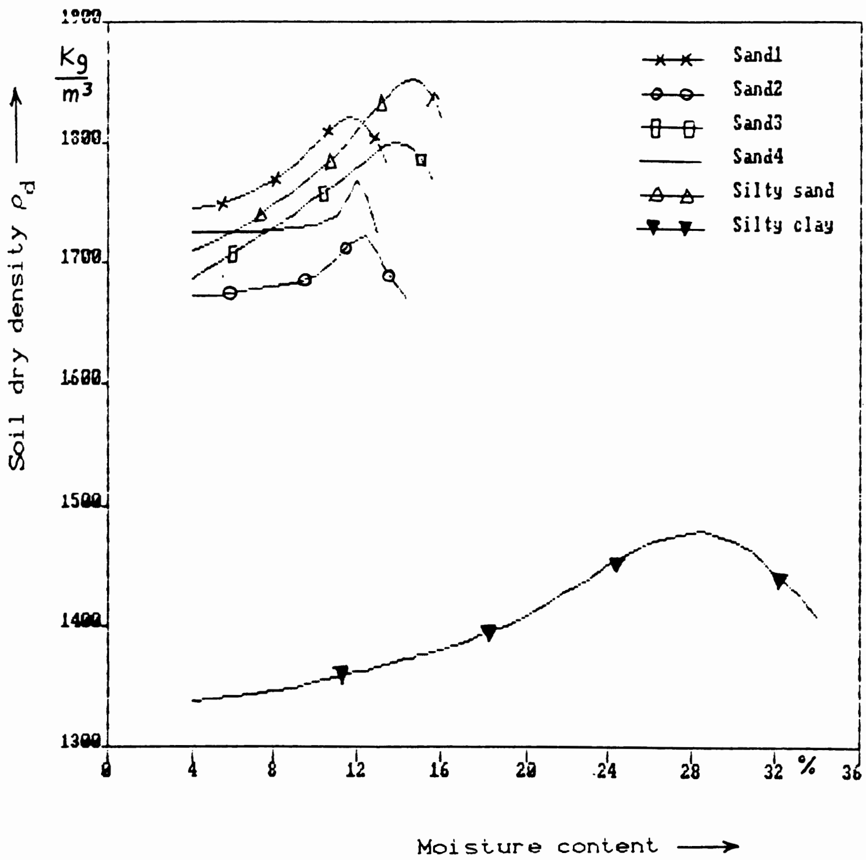

FIG. 2. Proctor curves for all investigated soils.

TABLE 3. Maximum dry density and optimum moisture content of soil types examined.

Soil type	(ρ_d)$_{max}$ (Kg/m^3)	θ_{opt} (weight %)
Sand 1	1820	11.6
Sand 2	1720	12.4
Sand 3	1800	13.8
Sand 4	1755	12.0
Silty sand	1850	14.7
Silty clay	1480	28.5

2.4 Permeability Test

Permeability is a soil property which indicates the ease with which water will flow through the soil. It depends on the size of the soil grains, properties of the pore fluid; especially viscosity, the void ratio of the soil, the shapes and arrangement of pores and the degree of saturation. Falling head method[14] is used for measuring the permeability of a saturated soil. The coefficient of permeability K is computed using the formula given in Ref. [14] :

$$K = \frac{a\ L}{A\ t} \ln \frac{h_1}{h_2} \tag{3}$$

where,

L = Length of soil in the permeameter (m),

A = Cross-sectional area of the permeameter (m^2),

a = Cross-sectional area of the water vessel (m^2),

t = Time required for falling water head from h_1 to h_2 (sec) and

h_1 & h_1 = Water heads (m).

The coefficients of hydraulic permeability K, are given in Table 4.

TABLE 4. The coefficients of hydraulic permeability of investigated sand types.

Soil type	Sand 1	Sand 2	Sand 3	Sand 4	Silty sand	Silty clay
ρ_d (Kg/m^3)	1640	1550	1620	1580	1665	1390
K (μm/sec)	35	49	28	41	0.406	0.0217

2.5 Measurement of pF-Curve by Means of Gravity for Sandy Soils

The purpose of this test given in Ref. [4] is the determination of water suction tension versus the degree of saturation; called pF-curve. Soil void ratio (e) and the degree of saturation (S) can be calculated using the following relations[14]

$$e = \rho_1 \frac{G_s}{\rho_d} - 1 \tag{4}$$

$$S = \frac{\theta\ G_s}{e} \tag{5}$$

where,

ρ_1 = Water density (= 1 Kg/m^3) and

G_s = Specific gravity of a soil.

In the determination of pF-curves for soil types sand 1, sand 2, and sand 3 at room temperature; gravity force was used as the only external force in adjusting the suction tension. Figure 3 shows such pF-curves for soil types under study. It should be

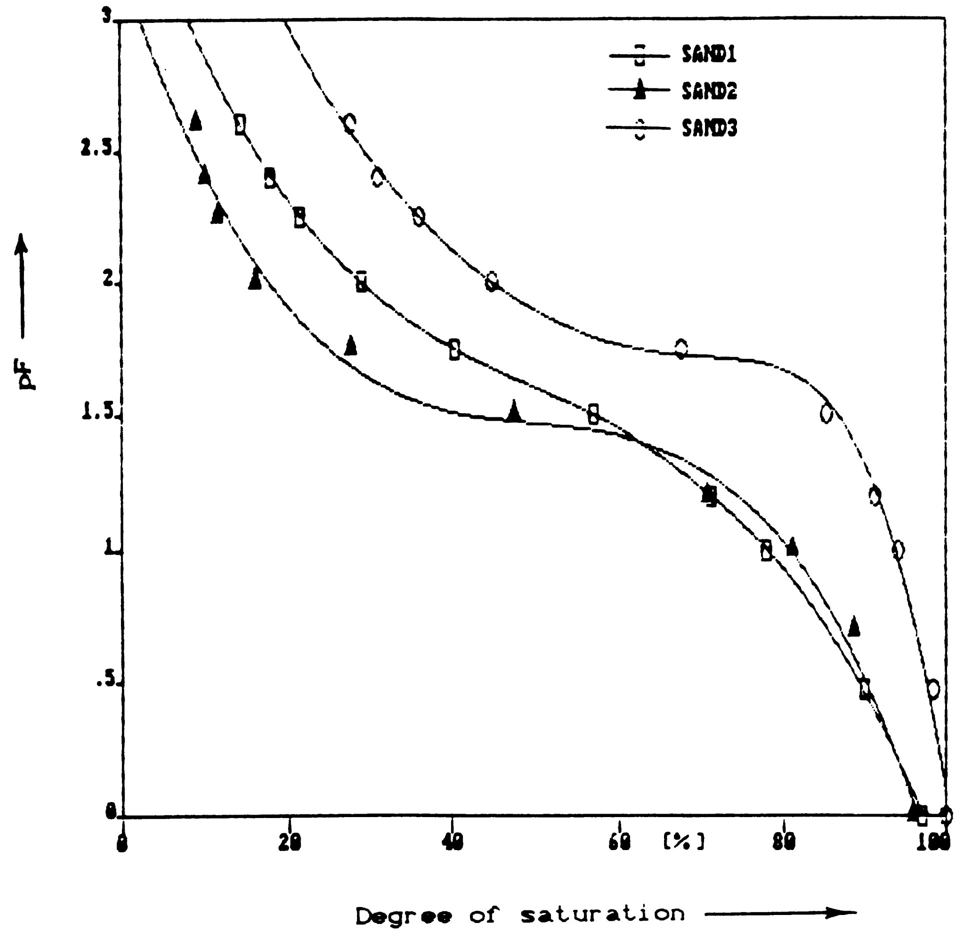

FIG. 3. pF-curves for sand samples 1, 2 and 3.

noticed here that the shape of the pF-curve depends upon the soil gradation curve, and moisture content.

In comparison of the pF-curves of different sands, although the shapes of the curves are almost the same the pF-curve sand 3 is shifted upwards. This means that sand 3 has a better water retaining capacity than sand 2 and sand 1 due to the larger loam fraction of sand 3.

2.6 Thermal Test for Studying the Drying- out Phenomenon in Sandy Soils

The drying-out in a soil is controlled by the factors : Moisture content, the heat flux density and cable surface temperature[4].

All soil samples were compacted to a dry density equals to 90% of the maximum proctor density. The experiment steps are :

a) The sample holder is filled with soil to be investigated and is subjected to the required water column height and the arrangement is left 24 hr.

b) The temperature of the different points in the soil sample is measured by using copper constantan thermocouples, which are put at different points in the soil. Their terminals are collected and connected to the Ramp-Scanner of Data Logger apparatus which is connected to a special printer (the 2nd part of Data Logger apparatus); called Digistrip III, for automatic recording of temperature.

c) The power of the heating element is adjusted so that the moist soil is subjected to a constant value of heat flux density (Q_h , W/m^2). Date and time are recorded on Digistrip III.

d) The temperature is recorded every one hour, until the temperature distribution in the sample has become stationary. From the temperature gradient (dT/dz, °C/m) in the top part of the sample and the heat flux density (Q_h) introduced there, the STR (γ) can be computed with the aid of the formula[4]

$$\gamma = \frac{dT / dZ}{Q_h} \tag{6}$$

Drying-out becomes apparent by a discontinuity in the temperature gradient at the top part of the sample.

e) It is enough to record the temperature against time every 4 hr. The conditions are left unchanged for 13 to 15 days, in order to establish with sufficient certainty whether migration takes place or not.

f) The temperature-time curve for each sample as well as the temperature against distance are drawn. STR at the points at which drying-out not occur (*i.e.*, at stationary state) as well as the STR of the top layer of the sample are calculated.

g) The moisture content, is determined by weighing, versus distance is drawn and the points which are completely dried can be pointed out.

h) The pF and Q_h curves of sandy soils are drawn and the stable and unstable regions can be determined.

For studying the drying-out phenomenon in sandy soils the first step was to record the temperature against time of three samples for each sand at the stated conditions of heat flux density, moisture content and degree of compaction. Figure 4 shows the temperature-time characteristics for sand 2 at the stated conditions. Similar temperature-time characteristics for sand 1 and sand 3 could be obtained at the different stated conditions. The numbers from 0 to 8 shown in Fig. 4 represent the distance in (m) of soil points from the heater. It should be noted that as the distance decreases towards the heater the temperature-time characteristic becomes higher.

Drying phenomenon in sand 1, sand 2 and sand 3 can be explained as follows: At a given value of the heat flux density and the water suction head, a higher temperature (points near to the heater) increases the saturated vapour pressure and consequently a more intensive transport of vapour. On the other hand, sand water retaining capacity is lowered with higher temperatures. As a result there is more pore volume available for vapour transport and less for the opposite transport of liquid water. These factors cause faster drying out of the soil.

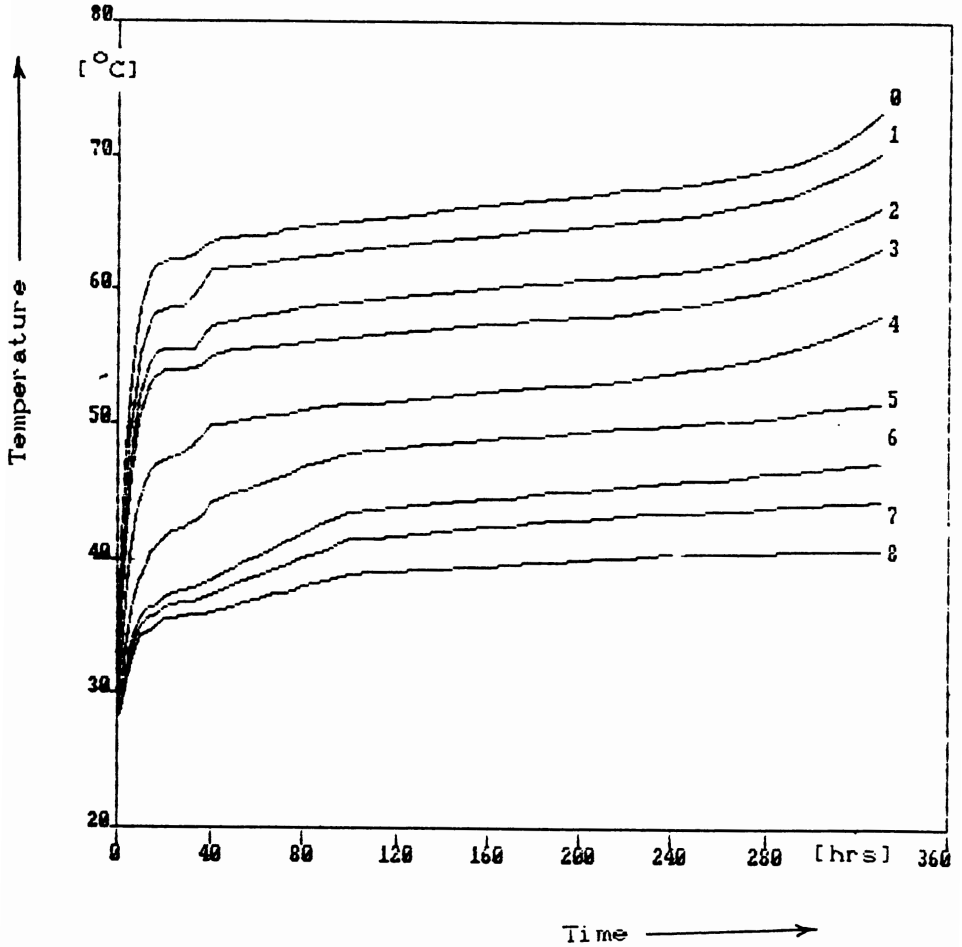

FIG. 4. Temperature versus time for sand 2.

Sand 2 : ρ_d = 1550 Kg/m^3 , Q_h = 360 W/m^2 , pF = 1.35

The temperature distributions at different points in all investigated samples (*i.e.*, temperature against distance) after 15 days of heating at the stated conditions are shown in Fig. 5a, 5b and 5c. The thermal resistivity of all investigated sands after 15 days of heating at the stated conditions varied in the range from 0.6 to 3°C. m/W. While, it varied in the range from 0.6 to 1°C. m/W at stationary state (moist soil case) during heating process. As shown in Fig. 4, the temperature increases rapidly at the points 0, 1, 2 and 3. On the other hand, the temperature versus distance, as shown in Fig. 5, shows two lines approximately straight for sands 1, 2 and 3. The straight line corresponding to points 8, 7, 6, 5 and 4 represents the stationary state condition for the three types of the investigated sands. The thermal resistivity calculated from this line for various sands varied in the range from 0.6 to 1°C. m/W. On the other hand, straight line corresponding to points 3, 2, 1 and 0 represents another case which is de-noted "Dry case". The thermal resistivity calculated from this line for various sands varied in the range from 1.3 to 3°C. m/W. In other words at the measured temperature distribution (Fig. 5) the discontinuity in the curve indicates the separation between two zones with high respectively low thermal resistivities or with dry respectively moist soil. The drying-out started in sand 2 at a temperature of 54°C. In sands 1 and 3 the drying-out started at a temperature of 57°C.

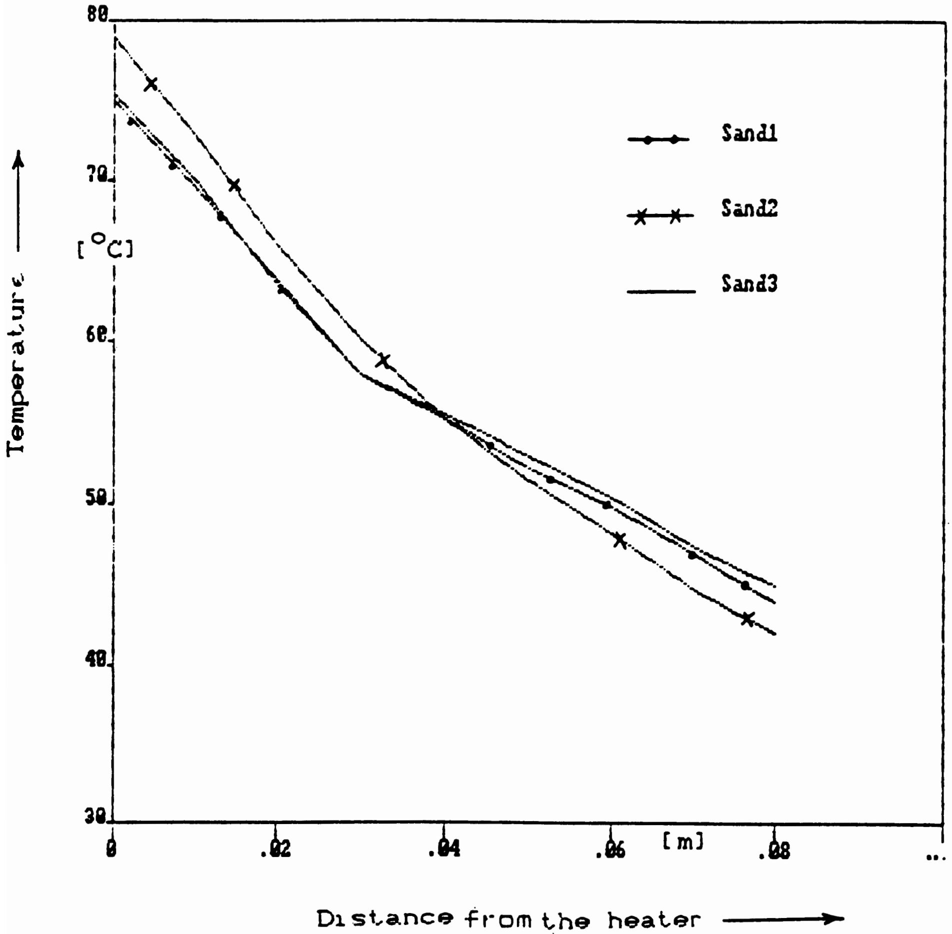

FIG. 5. Temperature versus distance for various sand types.

Sand 1 : ρ_d = 1640 Kg/m^3 , Q_h = 350 W/m^2 , pF = 1.92
Sand 2 : ρ_d = 1550 Kg/m^3 , Q_h = 360 W/m^2 , pF = 1.35
Sand 3 : ρ_d = 1620 Kg/m^3 , Q_h = 400 W/m^2 , pF = 1.85

Figure 6 shows the moisture distribution in the investigated samples at the stated conditions. All points of temperature greater than 54°C (in sand 2) and 57°C (in sands 1 and 3) had approximately zero moisture content in this confirms the occurrence of drying-out phenomenon in all investigated samples. This is due to moisture migration under the influence of heat coming from the heater (or buried cables).

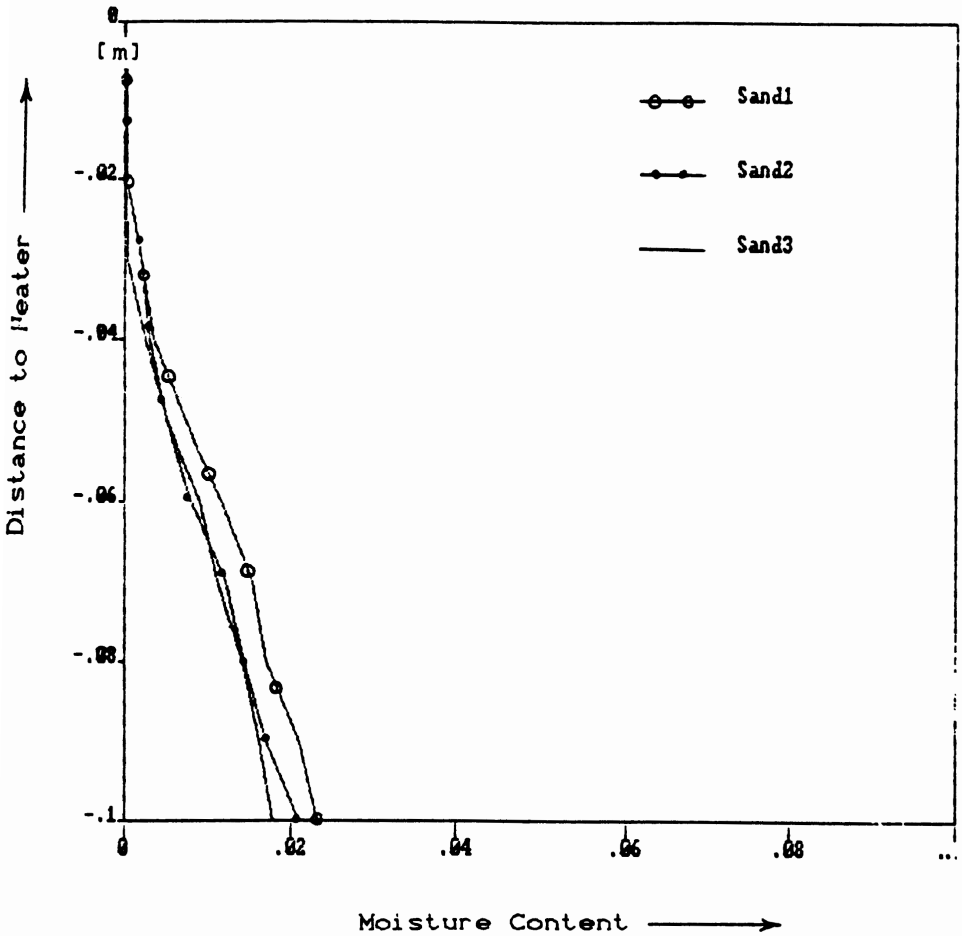

FIG. 6. Moisture distribution at different points in sand samples.

Sand 1 : ρ_d = 1640 Kg/m^3 , Q_h = 350 W/m^2 , pF = 1.92
Sand 2 : ρ_d = 1550 Kg/m^3 , Q_h = 360 W/m^2 , pF = 1.35
Sand 3 : ρ_d = 1620 Kg/m^3 , Q_h = 400 W/m^2 , pF = 1.85

The influence of sand properties on the measured critical conditions is shown in Fig. 7. The measured critical conditions have been determined for investigated soil types at the same degree of compaction (90% of the maximum proctor density) and a top temperature of 54°C for sand 2 and 57°C for sands 1 and 3 respectively. The difference in critical conditions for the three types of sand is due to the clear discrepancy between the pF-curves of various sands given in Fig. 3. According to Fig. 7, at a given value of the water suction tension, sand 1 and sand 3 have higher degrees of saturation as compared with sand 2. The curves for sand 1 and sand 3 are being to the right of that for sand 2 as shown in Fig. 7. This is because the ratios between pore volume available for vapour transport and pore volume for the transport of liquid water in the opposite direction are smaller than the corresponding ratio for sand 2.

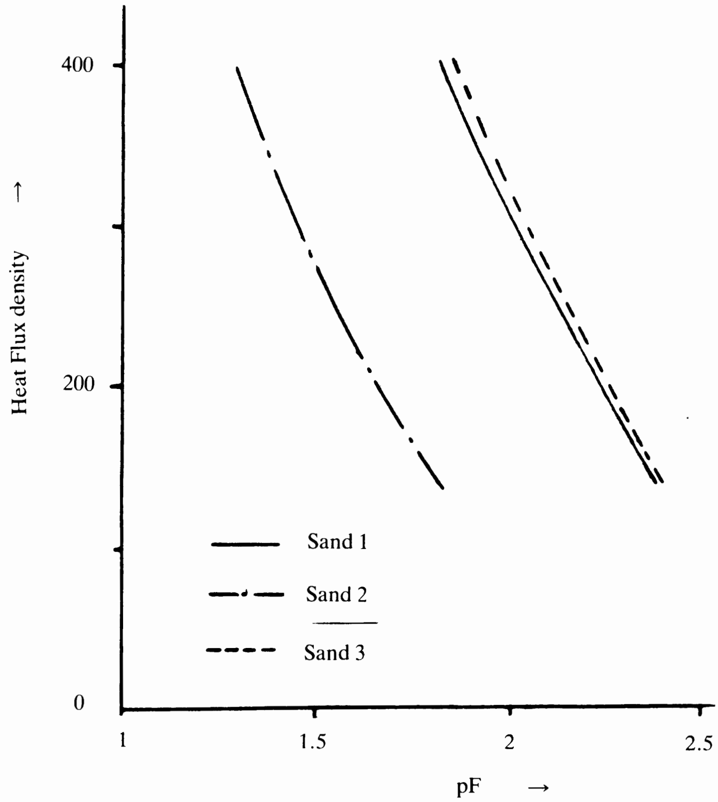

FIG. 7. Critical conditions for sand samples 1, 2 and 3. Top. temperature: 54°C for sand 2 and °57 for sands 1 and 3. Degree of compaction = 90%.

According to Fig. 7 a combination of heat flux density and water suction tension to the right of any curve will result in unequilibrium state with drying-out for that sand. On the contrary, a combination to the left of any curve however, will give an equilibrium state without drying-out of the sand. As shown in Fig. 7, sand 2 loses its moisture content faster than sand 3.

2.7 Field Experiment

With the aim of investigating the thermal behaviour of the soil around high voltage power cables, under practical conditions, field experiment was carried out in Cairo zone, with cables buried in silty sand soil. In this section cable current, the distributions of temperature at 5 soil points and the distribution of moisture are given.

In the test field, one square trench of 0.8 m side and 1 m depth was dug where three similar 400 mm^2, aluminium single-core cables in flat formation, with a distance of 0.12 m between centers, were previously buried in silty sand soil. It is noted that most high voltage cables up to 66 KV are buried between 0.8 and 1 m below ground surface as given in Ref. [16]. The grain size distribution of silty sand soil and its proctor curve are shown in Fig. 1 and 2 respectively. Each cable core has an outer diameter of 0.06 m with XLPE insulation of thickness 0.006 and PVC covering of thickness 0.0035 m. Figure 8 shows such arrangement.

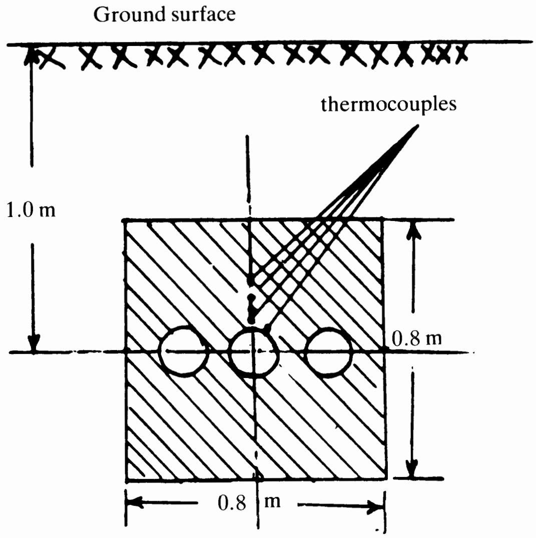

FIG. 8. Cross-sectional area of field test arrangement.

To measure temperatures, copper constantan thermocouples were placed at distances of respectively 0, 0.01, 0.03, 0.08 and 0.13 m from the center cable surface. The air temperature was recorded by a thermometer.

Figure 9 shows the variations of cable surface temperature and the temperatures in some soil points, cable current, soil ambient temperature and the moisture content with time. During the first 5 months the recorded soil temperatures, at 0, 0.01, 0.03, 0.08 and 0.13 m above the center cable, are approximately constant. At the end of June with the beginning of July and August 1991 a different thermal behaviour at the points 0, 0.01 and 0.03 is recorded. Cable surface temperature is rapidly increased. Thus the presence of a dry zone around the cables manifests itself in the temperature measurements by the occurrence of a discontinuity in the temperature gradient of the surrounding soil. On the other hand, the moisture content value was approximately 0.042 (m^3/m^3) during July-August period. While its value at the beginning of field experiment was 0.15 (m^3/m^3). In October, November and December 1991 the recorded distributions of temperature at different soil points showed a slowly decrease in temperature. This is due to the decrease in soil ambient temperature and the increase of air moisture content at soil surface.

The measured temperature at 1 m below ground surface was 30°C. Usually the value of ground temperature is constant at such depths below soil surface. Also, the effect of ground temperature on the occurrence of dry zones in the soil surrounding

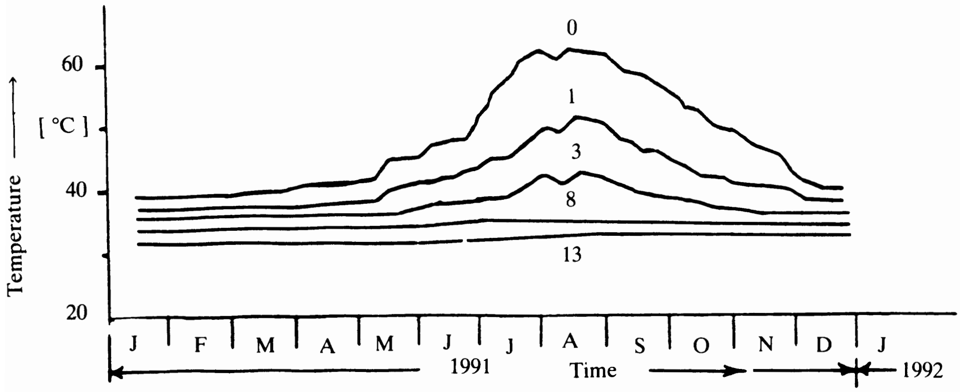

FIG. 9(a). Temperature at cable surface and at 1, 3, 8 and 13 cm above it.

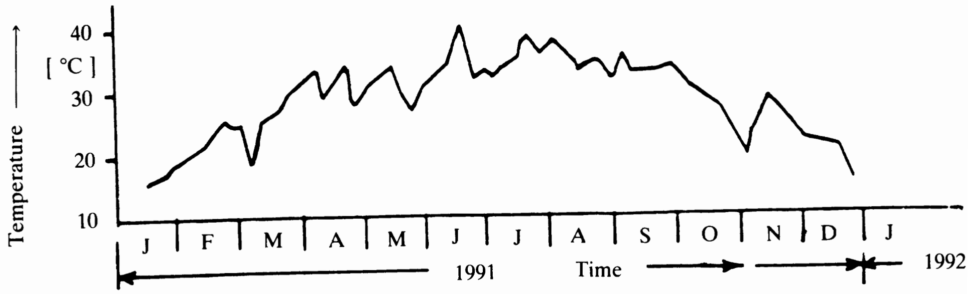

FIG. 9(b). Variation of ambient temperature measured directly at ground surface all over one year.

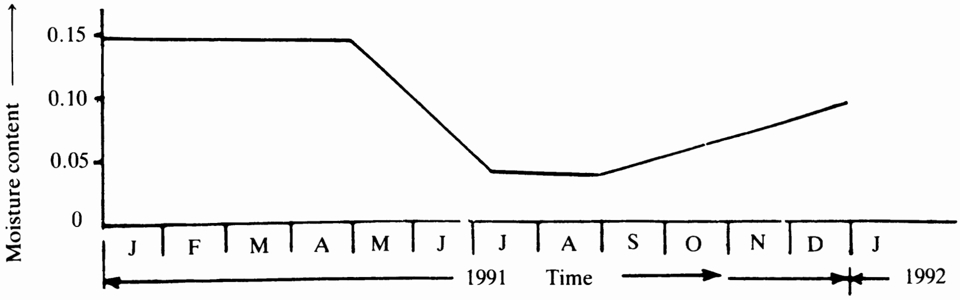

FIG. 9(c). Variation of moisture content during one year period in soil around cable surface.

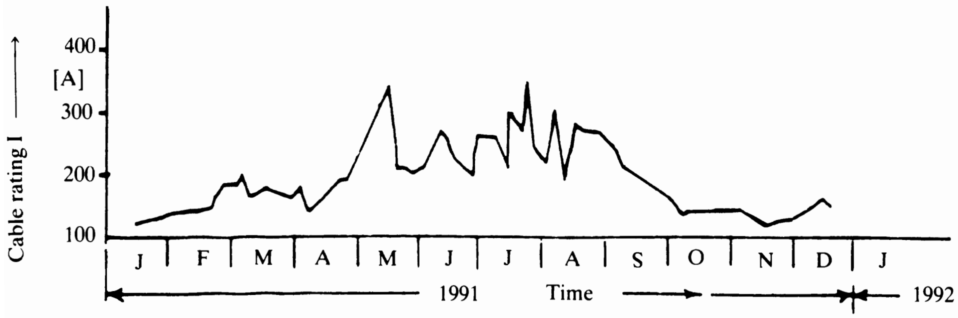

FIG. 9(d). Variation of measured cable rating during one year period.

trolled by the factors: Soil moisture content, cable losses and cable surface temperature.

Drying-out was found to develop during July and August. This is may be due to the heat emanating from the cable which makes the cable surface temperature rises. It should be noted that the previous period was characterized by high ambient temperature and zero annual rainfall.

3. Discussion

The obtained values of specific gravity of all investigated soils, presented in this paper, lie in the ranges of G_s published in Ref. [15] for sandy and clay soils.

In comparison of grain size distribution of sands investigated in Ref. [4, 5, 9] using sieve analysis with the grading curves of sand 1, sand 2 and sand 3, there is some discrepancies between them. These discrepancies are due to the difference in the percentage ratios (by weight) of gravel, sand and loam between different sands.

In comparison of the published proctor curves of sands in Ref. [4, 5, 9] with that given in Table 3, the discrepancies are due to the differences in grading curves, loam content and the shape of grains.

The discrepancy between the coefficients of saturated hydraulic permeability of sands investigated in Ref. [9], and sand types investigated in this work is due to the difference in grading curves and the dry densities of sands.

The drying-out phenomenon in all investigated sands[4, 5, 9] started at a temperature of 55°C and this tendency is in good agreement with the data presented in this work. A good agreement between the published results in Ref. [4, 5, 9] and that found in this paper about the influence of sand properties on the measured critical conditions.

4. Conclusion

1) The results of specific gravity, grain size distribution, permeability, compactibility, and pF-curves are presented. Such results are used in the calculations of temperature and moisture distributions in the soil surrounding the buried cables and consequently their ratings.

2) The results of both the thermal test and field experiment showed that drying-out could be developed in the soil surrounding the buried cables. As a result, the occurrence of dry zones should be taken into consideration when designing systems using buried cables.

3) In order to avoid the sensitivity for drying-out, it is recommended that the soil around a buried cable is compacted as strong as possible to increase its density. As a result, its thermal resistivity is reduced.

4) For avoidance of drying-out, power cables must be backfilled with soils (such as sand 3) of high thermal conductivities such that the dissipation of heat generated by such cables becomes more easily. Also, these backfill soils should have a relatively high loam content as well as better water retaining capacity.

References

[1] **Omar, N., Abdel-Hadi** and **James, K.M.,** Coupled heat and water flows around buried cables, *J. Geot. Eng. Div., ASCE,* **107**(GT11) Nov.: 1461-1487 (1981).

[2] **Arman, A.N., Cherry, D.M., Gosland, L.** and **Hollingsworth, P.M.,** Influence of soil moisture migration on power rating of cables in h.v. transmission systems, *Proc. IEE,* **111**(5): 1000-1016 (1964).

[3] **Milne, A.G.** and **Mochlinski, K.,** Characteristics of soil affecting cable ratings, *Proc. IEE,* **111**(5) May: 1017-1039 (1964).

[4] **Kema/Heidemi J** report, *Moisture migration and drying out in sand around heat dissipating cables and ducts,* A theoretical and experimental study, Oct. (1981).

[5] **Vermer, J., Van de Wiel, G.M.L. M.** and **Snijders, A.L.,** The conditions controlling the drying out of soil around power cables, *Electra,* **84** (Oct.): 53-67 (1982).

[6] **Donazzi, F., Occhini, E.** and **Seppi, A.,** Soil thermal and hydrological characteristics in designing underground cables, *Proc. IEE,* **126**(6) June: 506-516 (1979).

[7] **Randon, T.L.** and **Mitchell, J.K.,** Factors influencing thermal resistivity of sands, *J. Geot. Eng., ASCE,* **115**(12) Dec.: 1683-1699 (1989).

[8] **Haran, S., Radhakrishna, Ka-Ching Lau** and **Adrian, M. Crawford,** Coupled heat and moisture flow through soils, *J. Geot. Eng., ASCE,* **110**(12) Dec.: (1984) 1766-1784.

[9] **Groeneveld, G.J., Sinjders, A.L., Koopmans, G.** and **Vermeer, J.,** Improved method to calculate the critical conditions for drying out sandy soils around power cables, *Proc. IEE,* **131** Pt. C, (2) March: 42-53 (1984).

[10] **Philip, J.R.** and **De Vries, D.A.,** Moisture movement in porous materials under temperature gradients, *Trans. American Geophysical Union,* **38**: 222-232 (1957).

[11] **Mochlinski, K.,** Assessment of the influence of soil thermal resistivity on the ratings of distribution cables, *Proc. IEE,* **123**(1) Jan.: 60-72 (1976).

[12] **Cox, H.N.** and **Coates, R.,** Thermal analysis of power cables in soils of temperature responsive thermal resistivity, *Proc. IEE,* **112**(12) Dec.: 2275-2283 (1965).

[13] **Gouda, O.E.,** Current rating of high voltage cables with respect to dried out zone formation, *12th International congress for statistics, computer science; social and demographic research, Cairo-Egypt, 28 March – 2 April 1987,* pp. 131-148.

[14] **William Lambe, T.,** *Soil testing for engineers,* Wiley Eastern Limited, U.K. (1977).
[15] **Jouzaif, Bolz,** *Engineering properties of soil and its measuring methods* (1985).
[16] **IEC Publication –** 287, *Calculations of the continuous current rating of cables (100% load factor)* (1982).

دراسة معملية للطبقات المجففة حول كابلات القوى الأرضية

أسامة السيد جودة* ، وعبد العزيز محمود عبد العزيز ، ورفاعى أحمد رفاعى** ، وزكى مطر****

*قسم القوى والآلات الكهربائية ، كلية الهندسة ، جامعة القاهرة ، الجيزة
**قسم الهندسة الكهربائية ، كلية الهندسة ، جامعة الأزهر ، القاهرة
جمهورية مصر العربية

المستخلص . يتناول هذا البحث دراسة الخواص المختلفة لأنواع متعددة من التربة ، لدراسة تكون طبقات مجففة حول كابلات القوى الكهربائية الأرضية ، وقد أخذ في الاعتبار خواص التربة من حيث الثقل النوعي للتربة والتدرج الحبيبي ودرجة التماسك واحتفاظها بالرطوبة . ومن المعروف أن التيار المار في الكابلات الكهربائية المدفونة في التربة يعتمد على أقصى درجة حرارة للموصل ، ويعتمد أيضا على المقاومات الحرارية للطبقات المختلفة المحيطة به ، وعلى وجه الخصوص المقاومة الحرارية للتربة . وقد لوحظ أن تكون الطبقات المجففة حول الكابلات المدفونة تبدأ في التكون عند درجة حرارة ٥٤ درجة مئوية في بعض أنواع التربة ، وتبدأ عند ٥٧ درجة مئوية في البعض الآخر ، وذلك اعتمادًا على سرعة فقد التربة لبخار الماء . وقد أجريت دراسة معملية على كابل جهد متوسط ثلاثي الأطوار محمل في الشبكة ومدفون على عمق مائة سنتيمتر من سطح الأرض ، وتم دراسة :

١ – التوزيع الحراري فوق السطح الخارجي للكابل على مدار عام ١٩٩١م .
٢ – التغير في درجة حرارة الجو المحيط عند سطح التربة .
٣ – توزيع الرطوبة حول الكابل على مدار السنة .
٤ – أقصى أحمال على مدار السنة .

وقد تم التعرف على السلوك الحراري للتربة من خلال القياسات ، وتم تحديد زمن تكون طبقات جافة حول الكابلات .