العنوان:	Dewatering and the Deterioration mechanisms in sandstone structural elements and suggestive treatments to Elkarnak Temples
المصدر:	مجلة كلية الآثار
الناشر:	جامعة جنوب الوادي - كلية الآثار بقنا
المؤلف الرئيسي:	A., Abd El kareem E.
المجلد/العدد:	ع7
محكمة:	نعم
التاريخ الميلادي:	2012
الشهر:	يوليو
الصفحات:	5 - 27
رقم MD:	933888
نوع المحتوى:	بحوث ومقالات
اللغة:	English
قواعد المعلومات:	HumanIndex
مواضيع:	معابد الكرنك، ترمين الآثار، التدهور المعمارى، الحضارة الفرعونية، مدينة الاقصر
رابط:	http://search.mandumah.com/Record/933888

Dewatering and the Deterioration mechanisms in sandstone structural elements and suggestive treatments to Elkarnak Temples

Abd-Elkareem. E.A. (•)

Journal of Faculty of Archaeology at Qena

(•) Qena, Faculty of Archaeology, South Valley University, Egypt

Abstract

cracks are considered among the most important indicators which tell us that there is something that affects the constructive safety of temples, cracks are also important because they indicate whether there is a relative movement among different parts or not. They tell us about the positions where there are tension stresses among different parts. some walls suffer from leans whether these affecting the total wall or buckling in limited parts of walls and this has led to variant landfall of Elkarnak Temples all years around, this landfall resulted from the erosion of foundations, earthquakes and extension or contraction and it also resulted from the mistaken additions or modification.

Keywords Static forces, Elkarnak Temples, Landfall, loads, Monitoring, Lean, Sandstone, Quartz

1. Introduction

Static forces It depends greatly on time factor in weakening the attraction of materials [1] as result of reactions which leads to the phenomenon of removing deterioration or perfect deterioration[2].In all aspects it comes to an end due to continuous remove away to which the material exposed [3].

Elkarnak Temples are considered a historical record that is full of Egypt's history and civilization, starting from middle dynasty until potolemic rule of Egypt ([4]).

2. Total balance of Elkarnak Temples

Process of different constructive elements landfall were accounted a year and during this period it was indicated that there was no landfall and this show the balance and the stabilization of

(1) Fizner, B, et al., Weathering damage on Pharaonic sandstone monuments in Luxor- Egypt, Building and Environment,V.38,Issue,9-10,2003,P.1089-1103.

(2) Steacy,S.,et al., Damage mechanics model for fault zone friction ,CGJ, Geophysics. , Res. V.97, NBI 1992, P.587-594.

(3) Chu.J.,et al., Strain-softening behavior of granular soil in strain- Path testing ,IKJ Geotech. Engine Div Ascev 118 N.2 1992, P.121-132

[4]) Tawfic S., History of architecture in ancient Egypt - Luxor ,Cairo ,1990, (PP.106&107

foundation[٥]. Thus most constructive elements of these temples, particularly foundations don't need any support. They bear loads carried to them from the foundation safely, except some foundation [٦] Fig. (1&2).

2.1. Loads calculation

This aims to document loads values which affect walls before restoration .after that we estimate the stresses on section and compare them with supposed safe stresses taking into consideration safety factor.

2.2. Calculating total loads carried on soil

2.2.1. Static loads

The most important of these loads are anchoring loads .anchoring loads include dead loads and living loads, dead loads are ground layers[٧] and their weight in general .living loads are very small because there was no dangerous living loading presented at the area of the study.

(5) Baggio , P., et al ., analysis of moisture migration in the walls of the S.Maria Del Miracali church in new conservation of stone and other materials , Paris 1993 , P.170 .

(6) Hirao, K., et al., Cyclic strength of underconsolidanted clay Technical note, soils found V.32 N٤,١٩٩١. .P.180-186.

(7) Chu. J., et al op cit, P.121-132.

2.2.2. Dynamic loads

They are the most important and dangerous loads which we must take into consideration to study chosen temples constructive elements because of their effects on these elements [A] , dynamic loads may include wind loads and earthquake loads, wind loads are estimated on the building according to the Egyptian code of loads and forces of 1993([9]).

2.3. General design of monitoring program

The program monitoring the settlement of temples includes a series of continues measurements intended to identify different kinds of movements include the following

1- measuring the buildings height to define whether these buildings are submerged or high
2- measuring the distance between a group of buildings to know whether these buildings move to which direction

measuring the width of cracks and he lean of the pillars of the temples

The three kinds of measurements can be described as follows

2.3.1. Accurate level measurement

This measurement is used to measure the accurate vertical height (in relation to the sea level) at a fixed point on old building.

2.3.2. Stations measurements as whole

This kind of measurement includes vertical and horizontal measurements between a group of the temples buildings, here survey measurements are conducted between the places which can be seen from survey and reference point , the resulting engineering calculation tells the monitoring program if any of the buildings of the temples moves in relation to other buildings.

2.4. Measurements of cracks, deviation and lean

Sensors are fixed on chosen places on buildings of temples to measure the lean of particular center away from what is vertical (inside a plane)or width of crack in the building, measure of cracks and lean are used on these chosen places on which sensors are put.

2.4.1. Lean sensor

(8) Chen,Y.C.,et al., Evolution of shear modulus and fabric during shear deformation soils found V.31 N4 1991 P.148-160.

[9]) Egyptian code of stress calculation on constructive works, ministry of housing, (N.45.1993.

Lean sensor is fixed vertically or horizontally, when the position and center of the measure change little , the device will give and electric sign that is proportion to the amount of movement, this is measured by a mobile instrument to be connected to the measures of lean which fixed in Elkarnak Temples.

The measurements of ground water levels help to identify whether there are ground water levels that are corresponding to the design system , measures of water level are fixed ,nearly at the end of building stage (design construction), at the late months of the year 2006 .,then , they were started again through the project of de-watering in August , 2007 in Elkarnak Temples, these new locations which have the marks k1,k2,k3 in Table (1) helped to monitor water level in Elkarnak Temples from east to the west.

3. Study and discussion

3.1. The examination of sandstone

Samples taken from Elkarnak Temples by polar Microscope shows that the percentage of quartz is the highest because it is 94% out of the total metals found in the samples, it indicates that the percentage of feldspars reaches 5% and rock fragments 0.5%, the percentage of cement materials is 10% and it was classified as quartz (quartz Arenite), the quartz granules are under a circular angle, it was found that the percentage of porosity and permeability is high(١٠) , the microscopic examination showed that the main components and mineral of sandstone is quartz and it took different forms(١١) as shown in Fig.(5), the crystals of quartz appeared unequal in their dimension and volumes that is they are crystals of great and moderate granulation(١٢), another microscopic examination indicated the angular quartz granules transform into semi-angular granules and this shows the quartz granules didn't move to far distances during the processes of deposition Fig. (6),in

(10) prince, C.M., et al., the effect of sandstone micro fabric upon relative permeability and points, Journal of petroleum science and engineering 24(1999), p. 170.

(11) Abd El Hady , M.M., Ground water and the deterioration of Islamic Buildings in Egypt , the Restoration and conservation of Islamic Monuments in Egypt AUC press, 1995 , pp.112 & 116 .

(12) Prince, C. M., et al., the effect of sandstone micro Fabric upon relative permeability and points, Journal of petroleum science and engineering 24 (1999), p. 170.

some samples quartz crystals appeared in a round and semi-round form and this shows that the quartz crystals moved to far distances during the processes of deposition, the examination indicates the erosion of some of the crystals edges and this erosion extends to the interior (١٣) ,the examination showed there are some clay minerals Fig. (5) and some iron oxides (١٤) Fig. (6).

3.2. The results of monitoring program

The results of monitoring program in the study are summarized in tables and drawings found in the end of this study; the results are compared according to the limits of tolerance to define the significance of any movement that is discovered ([15]) .

3.2.1. Surveying and measuring height

Vertical and horizontal movements were monitored in several locations inside Elkarnak Temples using the accurate level measurements and whole station measurements ([16]) , the measurements didn't show the volume of movement bigger than 3 mm, the movements less than 3mm weren't considered significant. Table (2) summarize the average ,the most and the least data values which were collected during the period starting from March ,2010 to August 2010 ,the collected data indicate that the measurements were at he limits of reading mistake and there was no significant movement in the buildings of the main temples Table (3) , monitoring of monuments ,during the past period , showed that the

(13) Wiedmann, H., et al., pigments of the bust of Nefertiti compared with those of the Karnak talats thermo chemical, 382, Issues1-2, 2002 P.239-247.

(14) Massari, I. , Quelques aspects dela protection des monuments historiques contre L'humidite , La degradat et La conservation de la pierre , unesco , P.73 .

([15]) Meyer.E. et al., a computerized solution for epigraphic surveys of Egyptian temples, Journal of archaeological science, V.33, issue11, PP.1605-1616.

([16])Fasi, E.A., et al., Building surveys and Reports , second Edition, Black well science , 1995,P.28.

buildings which were monitored are stable and there was no vertical or horizontal movement [17].

3.2.2. Tilt meters and crack meters

Tilt meters were located on the places which were chosen by the committee designated by supreme council of archaeology (SCA), these places were considered usually sensitive to estimated that the lean with the movement was less than 0.5 mm, the collected data didn't show any lean or deviation that was significant in any of the observed monuments during the last of the report period, Table (4) summarizes the data collected from Crack meters and Tilt meters, from the differences between initial readings and the observed readings , we can deduce the following

A) The differences in levels points in Elkarnak Temples contained the mean that is 0.3mm and standard deviation 0.8mm and these values are at the accuracy of the used accurate level.

B) The differences in whole stations points in Elkarnak Temples contain the mean 0.1mm and standard deviation 0.34mm and these values are with in the accuracy of the instrument of the used whole stations.

C) The above results agree to the monitoring program according to the contract between the SMT Company and the supreme council of archaeology which is carried out daily in the different locations of Elkarnak Temples.

4. Conclusions

The observation of groundwater maintains that the normal groundwater levels were reduced successfully to the aimed level in Elkarnak Temples due to the project of groundwater reduction and the aimed project level is 72 m.a.s.l for the area of Elkarnak [18].

The measurement of the movement of the temples indicate that there was no signification settlement in the buildings of the temples during the period of the study.

([17]) Martinet,G.,et al., Nature and weathering of the mortars used in the restoration of the temple of Amon at karnak.a bull liaison lab points chausses N182,1992,P.21-26.

[18] Ismaiel , M.B , studies of the deterioration phenomena in the Ptolemaic temple of Dendara , Bultine of the faculty of engineering , Assuit university , Vol. 27 , No .1 , January , 1999 , P . 245.

Certain locations were considered sensitive in a particular way to movement – The measures of lean and settlement were fixed in these places – and these locations remained stable and reliable until the end of the study period ,that is, the locations which were considered sensitive in particular way to movement remained stable and didn't have any destabilization during the study period, the monitoring program was improved during the study period by adding new good survey points and locations for measuring water level.

Figers

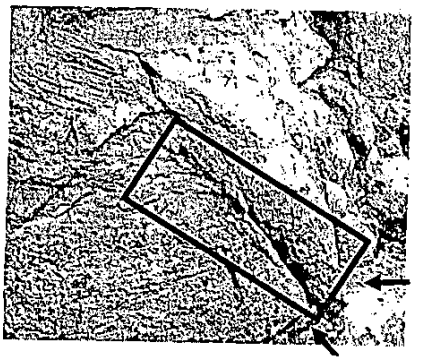


Fig. (1)
The second baylon in *Elkarnak Temples* indicates a leaning crack below the wall and the depth of the crack in this area can be seen, as we go upwards the depth and width of the crack become less this crack is due to the failure of the ability of soil to bear wall on it.

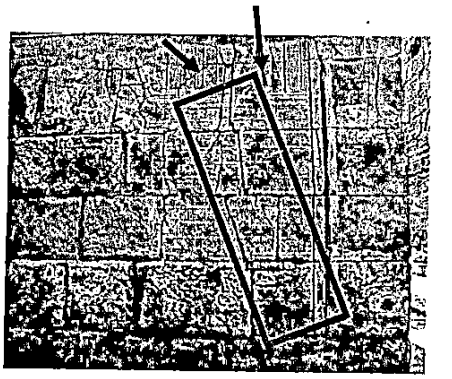


Fig. (2)
The north baylon, the second edifice shows a deep vertical crack this crack is deeper and wider at the bottom part and becomes less when it goes upwards.

Fig. (3)
The imbalance of the threshold above the pillars and walls bearing them ,it is observed that the threshold is driven to the lower part at the area of loading it on the middle pillar and this pillar has sliding (a fall) downwards, the threshold is pulled downwards with this pillar because it is the point of its loading, it is observed that this sliding and pulling of the threshold may lead to the entire collapse of this threshold if it is exceeded, the center of collapse is on the middle pillar bearing the threshold begins from the bottom to the top, novice versa

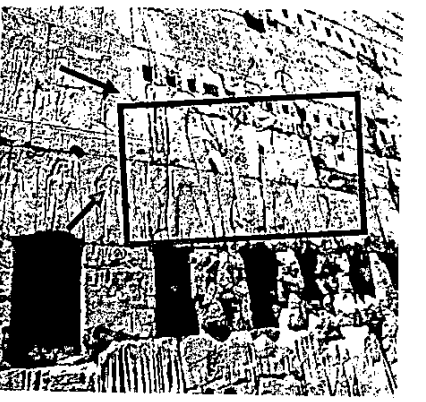


Fig. (4)
The deformation s and different damages which include the areas which work as shoulders for the threshold forming holes are beginning to collapse they are unable to do its task although holes are small, it is observed that the reason for this lies in the soil to a great extent and the loads located on shoulders are a factor that causes a partial collapse as a result of sliding

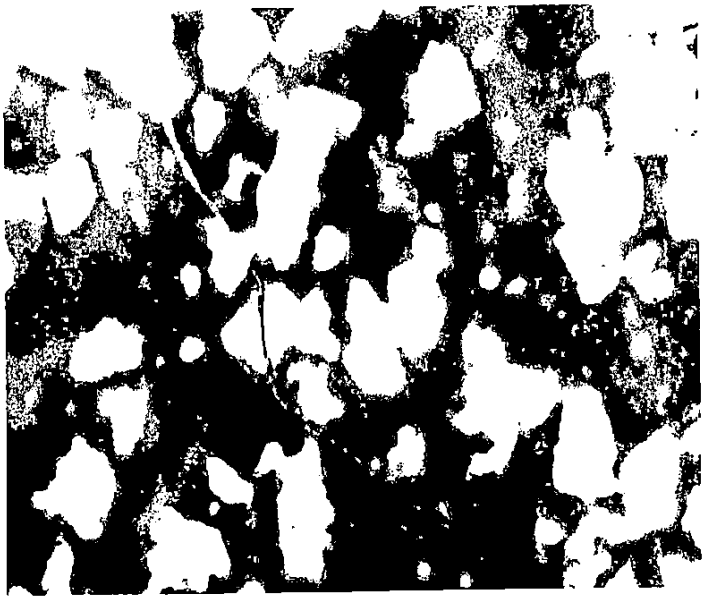


Fig. (5)
Shows a sample of sandstone from *Elkarnak temples X25 quartz arenite vertical light, this sample contains quartz as the main component and iron oxides as a cement material, noticeable breaking and fraction of the quartz granules and the angular and semi –angular forms of these granules, there are also fissures caused by the stresses on the samples because.*

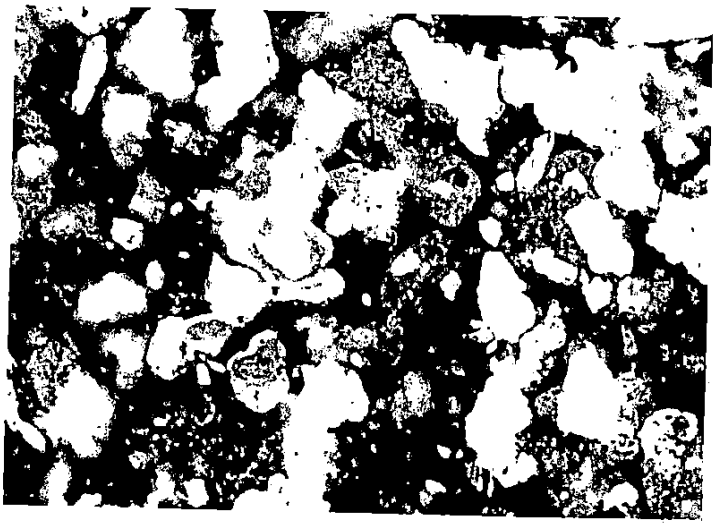


Fig. (6)

Shows a sample of sandstone from *Elkarnak temples X25 quartz arenite vertical light, this sample contains quartz as the main component and iron oxides as a cement material, noticeable breaking and fraction of the quartz granules and the angular and semi –angular forms of these granules, there are also fissures caused by the stresses on the samples because.*

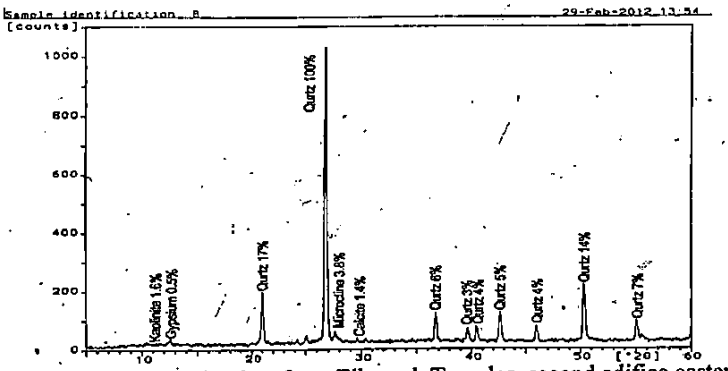


Fig. (7) a sample of sandstone taken from Elkarnak Temples, second edifice eastern wall, from the lower part of the wall to the interior.

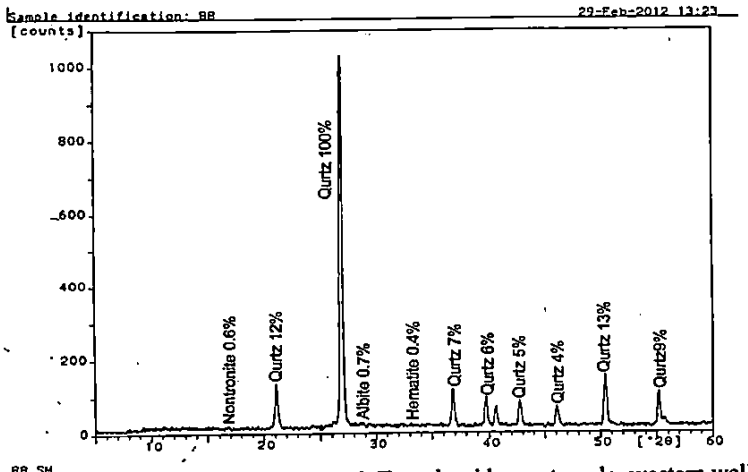


Fig. (8) a sample of sandstone taken from Elkarnak Temples, khensu temple, western wall from the inside

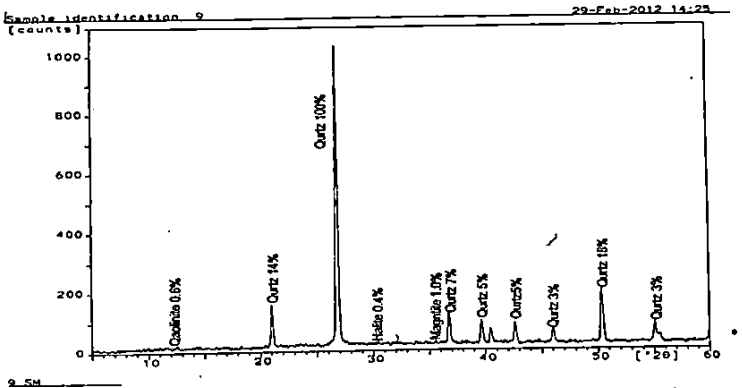
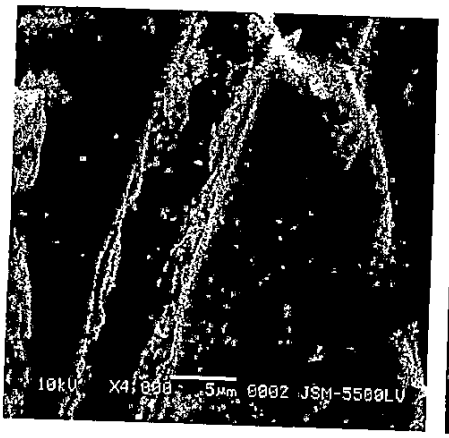


Fig. (9) a sample of sandstone taken from Elkarnak Temples, khensu temple, eastern wall from the outside



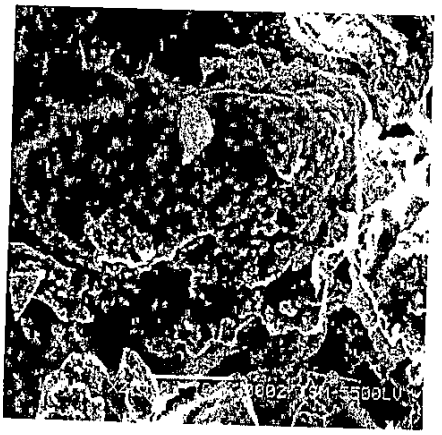
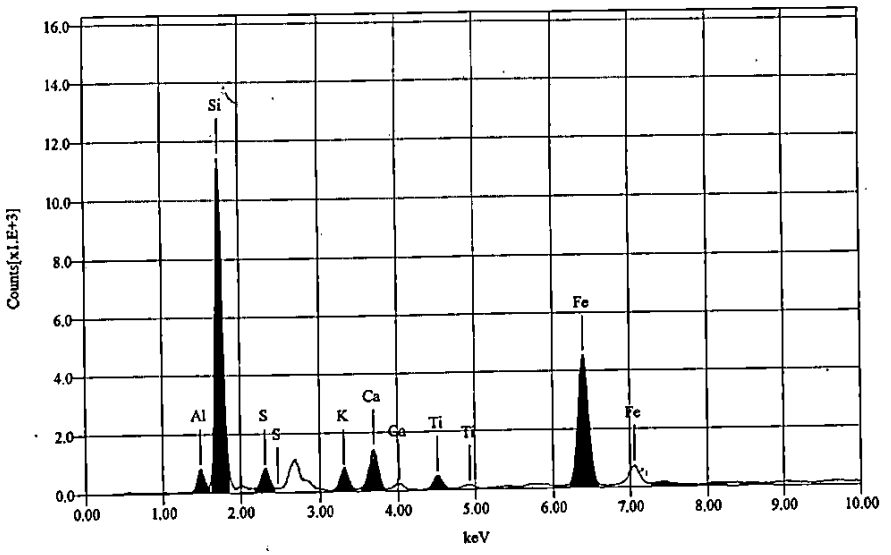


Fig. (10&11)was taken by S.E.M shows the damage of cement materials and a breaking in the granules of sandstone

Fig. (12) was taken by S.E.M shows a sample of needle salts found on the sandstone and shows salty clusters in the form of trees; it shows the crystallization of sodium sulphate, sodium chloride and gypsum due to the appearance and deposition of salts caused by underground water.

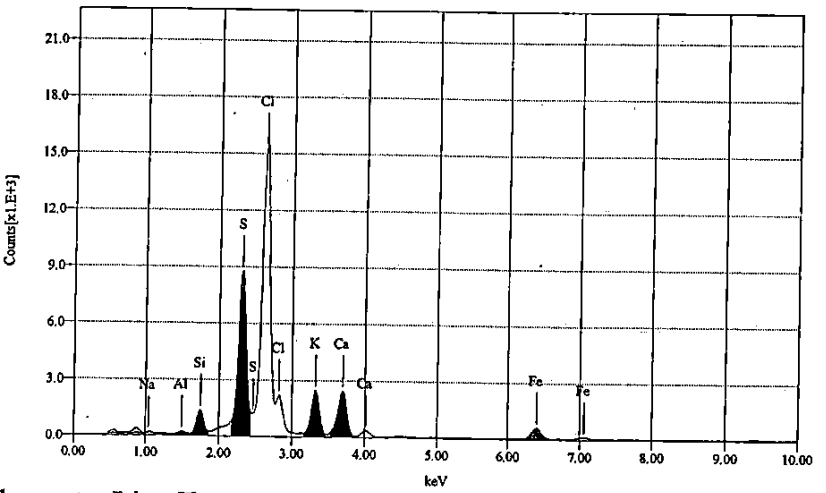
Fig. (13) was taken by S.E.M shows a sample of needle salts found on the sandstone and shows salty clusters in the form of trees; it shows the construction of the salty hard crust on the surface of the sandstone, there are variations in the forms of these salts



Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Al2O3	K	1.49	8.4242	5.4700	0.0068795	7644	0.2107
SiO2	K	1.74	72.7907	80.2063	0.0611336	126802	0.2490
SO3	K	2.31	3.4429	2.8471	0.0026381	9718	0.0864
K2O	K	3.31	2.9033	2.0404	0.0052350	10496	0.1087
CaO	K	3.69	4.8287	5.7006	0.0082965	19830	0.0925
TiO2	K	4.51	1.4023	1.1620	0.0023113	7226	0.0558
Fe2O3	K	6.40	6.2079	2.5737	0.0184334	79417	0.0274

Fig. (14) a sample of sandstone taken from Elkarnak Temples, from beginning of the entrance below the interior wall of the entrance, by

EDX ,it was observed that quartz dioxide is the main component and this sample contains the oxides of aluminum, iron, magnesium and quartz and calcium .



Element	Line Type	Energy	ms%	mol%	K	Net	Error%
Na2O	K	1.04	6.5552	5.7254	0.0033537	643	4.6884
Al2O3	K	1.49	1.6921	0.8984	0.0013768	1595	0.0956
SiO2	K	1.74	6.8208	6.1453	0.0064305	13906	0.1003
SO3	K	2.31	22.5296	15.2333	0.0287305	110335	0.0235
Cl	K	2.62	32.3309	49.3660	0.0691394	204662	0.0322
K2O	K	3.31	14.0457	8.0713	0.0163038	34079	0.0763
CaO	K	3.69	14.5739	14.0682	0.0140630	35044	0.0745
Fe2O3	K	6.40	1.4518	0.4921	0.0024072	10812	0.0222

Fig. (15) a sample of salts on the sandstone , Elkarnak Temples, by EDX ,this sample contains the oxides chloride and sulphate of aluminum, silicon and potassium calcium and iron.

Table (1) ,during the process of dewatering shows the locations of

taking the readings of cracks and lean and the ordinates of locations in Elkarnak Temples, supreme council of archaeology(SCA) 2010,weekly reports on the observation of the stat of Elkarnak Temples, the project of dewatering in Elkarnak Temples.

Location of Leveling points

Point	Location
K1	Second Pylon
K2	Second Pylon
K3	Hypostyle Hall
K4	Hypostyle Hall
K5	Hypostyle Hall
K6	Hypostyle Hall
K7	Obelisk of Tuthmosis I
K8	Ninth Pylon
K9	Ninth Pylon
K10	Ninth Pylon
K11	Ninth Pylon
K12	Tenth Pylon
K13.	Tenth Pylon
K14	Khonsu Gate
K15	Khonsu Gate
K16	Eastern Gate
K17	Eastern Gate
K18	Eastern Gate
K19	Eastern Gate
K20	Montu Gate
K21	Montu Gate
K22	Montu Gate
K23	Montu Gate

Location of Leveling points

Point	Location
S1	Obelisk of Ramesses I
S2	Obelisk of Ramesses I
S3	Ninth Pylon
S4	Ninth Pylon
S5	Ninth Pylon
S6	Ninth Pylon
S7	Ninth Pylon
S8	Ninth Pylon
S9	Tenth Pylon
S10	Tenth Pylon
S11	Tenth Pylon
S 12	Tenth Pylon
S13	Khonsu Gate
S14	Khonsu Gate
S15	Khonsu Gate
S16	Khonsu Gate
S17	Montu Gate
S18	Montu Gate
S19	Montu Gate
S20	Montu Gate
S21	Eastern Gate
S22	Eastern Gate
S23	Eastern Gate
S24	Eastern Gate
S25	Eastern Gate
S26	Eastern Gate

Table (2),during dewatering ,the differences of readings of

locations levels in Elkarnak Temples, SCA weekly reports concerning the observation of the state of Elkarnak Temples, ,the project of dewatering in Elkarnak Temples,2005-2010.
Levels and difference in levels of the observed points

Point No.	Initial Level on 8-10-2005 (cm)	Observed Level on 3-2-2010 (cm)	Diff. in Level (mm)
K1	7441.57	7441.60	0.3
K2	7445.76	7445.79	0.3
K3	7434.84	7434.87	0.3
K4	7437.03	7437.01	-0.2
K5	7458.95	7458.92	-0.3
K6	7462.82	7462.78	-0.3
K7	7594.30	7594.33	0.3
K8	7587.76	7587.79	0.1
K9	7612.65	7612.66	0.1
K10	7588.24	7588.25	-0.3
K11	7637.94	7637.91	0.3
K12	7617.14	7617.17	-0.3
K13	7602.43	7602.46	0.1
K14	7678.37	7678.34	0.3
K15	7673.38	7373.39	-0.3
K16	7653.61	7653.64	0.3
K17	7633.07	7633.04	-0.3
K18	7616.51	7616.48	-0.3
K19	7607.72	7607.70	-0.2
K20	7720.98	Broken	-------
K21	7745.85	7745.82	-0.3
K22	7754.41	7754.39	-0.2
K23	7724.07	Broken	--

Table (3),during dewatering ,the differences of readings of coordinates of the locations in Elkarnak Temples, SCA,2005-2010 ,weekly reports on observation of the state of Elkarnak Temples, the project of dewatering in Elkarnak Temples

Initial and Observed Coordinates of Points

Point No.	Initial Coordinates on 13-10-2005		Observed Coordinates on 30-1-2010		Diff. in Coordinates on 30-1-2010	
	E (m)	N (m)	E (m)	N (m)	ΔE (mm)	ΔN (mm)
S1	465647.7505	2844570.0486	465647.7493	2844570.0479	-1.2	-0.7
S2	465647.8535	2844569.8693	465647.8531	2844569.8698	-0.4	0.5
S3	465557.3763	2844351.7611	465557.3767	2844351.7600	0.4	-1.1
S4	465521.6534	2844364.3936	465521.6538	2844364.3941	0.4	0.5
S5	465559.5220	2844346.1733	465559.5213	2844346.1726	-0.7	-0.7
S6	465564.3604	2844347.6915	465564.3616	2844347.6904	1.2	-1.1
S7	465521.0345	2844362.4312	465521.0335	2844362.4300	-1.0	-1.2
S8	465511.0848	2844366.2826	465511.0838	2844366.2817	-1.0	-0.9
S9	465510.8616	2844263.4490	465510.8624	2844263.4501	0.8	1.1
S10	465505.7474	2844266.4456	465505.7451	2844266.4444	-1.3	-1.2
S11	465510.3776	2844260.9800	465510.3772	2844260.9795	-0.4	-0.5
S12	465503.9881	2844263.3700	465503.9881	2844263.3695	0.0	-0.5
S13	465389.8324	2844325.2222	465389.8321	2844325.2209	-0.3	-1.3
S14	465358.8617	2844330.3306	465358.8614	2844330.3295	-0.3	-1.1
S15	465389.3622	2844324.1715	465389.3614	2844324.1706	-0.8	-0.9
S16	465358.3266	2844329.2650	465358.3262	2844329.2644	-0.4	-0.6
S17	465954.0389	2844828.4840	465954.0379	2844828.4834	-1.0	-0.6
S18	465949.6968	2844830.8355	465949.6957	2844830.8344	-1.1	-1.1
S19	465956.2379	2844826.6873	465956.2368	2844826.6862	-1.1	-1.1
S20	465946.9881	2844831.5894	465946.9872	2844831.5882	-0.9	-1.2
S21	465907.4243	2844435.5930	465907.4247	2844435.5942	0.4	1.2
S22	465910.1341	2844440.8559	465910.1328	2844440.8560	-1.3	0.1
S23	465911.0056	2844443.4254	465911.0047	2844443.4252	-0.9	-0.2
S24	465910.7743	2844443.1820	465910.7730	2844443.1822	-1.3	0.2
S25	465905.6497	2844435.2041	465905.6486	2844435.2043	-1.1	0.2
S26	465909.3262	2844442.4399	465909.3272	2844442.4394	1.0	-0.5

Table (4),during dewatering ,the differences of readings of cracks

and leans values of the locations in Elkarnak Temples, SCA,2005-2010,weekly reports concerning the follow up and observation of the state of Elkarnak Temples, the project of dewatering

Sensor	Initial (8-10-2005)		Observed (30-1-2010)		Initial	Observed	Difference
	Reading	Units	Reading	Units	Abs. Value	Abs. Value	
Crack-1	1622.6	HZ	1624.9	HZ	1.058	1.109	-0.05
Crack-1	2277.9	HZ	2273.4	HZ	18.692	18.543	0.15
Tilt-1	-0.0393	V	-0.0541	V	0.106	0.051	0.05
Tilt-2	-0.010	V	0.0000	V	-0.090	-0.052	-0.04

[	Initial (8-10-2005)		Observed (3-1-2010)		Initial	Observed	Difference
	Reading	Units	Reading	Units	Abs. Value	Abs. Value	
Crack-1	1622.6	HZ	1625.8	HZ	1.058	1.128	-0.07
Crack-1	2277.9	HZ	2271.4	HZ	18.692	18.480	0.21
Tilt-1	-0.0393	V	-0.0452	V	0.106	0.084	0.02
Tilt-2	-0.010	V	0.0000	V	-0.090	-0.052	-0.04

Table (5) the readings of the coordinates of wells location in Elkarnak Temples, 2005, a report prepared by SWECO international Sweden.

1- El Karnak Temple

BH No.	EAST	NORTH
BH 101	465204.590	2844725.470
BH 102	465463.460	2844913.470
BH 103	465561.120	2845066.500
BH 104	465704.360	2845332.370
BH 105	466071.610	28-45140.290
BH 106	466071.610	2844638.530
BH 107	466010.400	2844412.380
BH 108	465891.380	2844173.740
BH 109	465665.010	2843843.320
BH 110	465477.530	28-43609.980
BH 111	465200.140	2843384.370
BH 112	465091.440	2843671.180
BH 113	464952.420	2843968.260
BH 114	465016.280	2844373.000

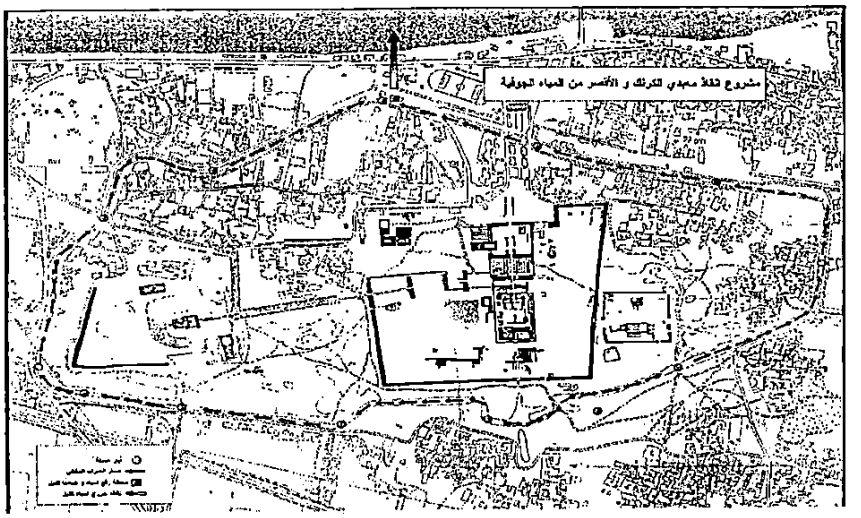


Fig. (16) the direction of dewatered from below Karnak Temples and direction of its pumping in the nile ,2005, a report prepared by SWECO international Sweden

References

1. Abd El Hady , M.M., Ground water and the deterioration of Islamic Buildings in Egypt , the Restoration and conservation of Islamic Monuments in Egypt AUC press, 1995 .
2. Baggio , P., et al ., analysis of moisture migration in the walls of the S.Maria Del Miracali church in new conservation of stone and other materials , Paris 1993.
3. Chen,Y.C.,et al., Evolution of shear modulus and fabric during shear deformation soils found V.31 N4 1991.
4. Chu.J.,et al., Strain-softening behavior of granular soil in strain- Path testing ,IKJ Geotech. Engine Div Ascev 118 N.2 1992.
5. Fasi, E.A., et al., Building surveys and Reports , second Edition, Black well science , 1995.
6. Fizner, B, et al., Weathering damage on Pharaonic sandstone monuments in Luxor- Egypt, Building and Environment,V.38,Issue,9-10,2003.
7. Hirao, K., et al., Cyclic strength of underconsolidanted clay Technical note, soils found V.32 N٤,١٩٩١.
8. Ismaiel , M.B , studies of the deterioration phenomena in the Ptolemaic temple of Dendara , Bultine of the faculty of engineering , Assuit university , Vol. 27 , No .1 , January , 1999.
9. Martinet,G.,et al., Nature and weathering of the mortars used in the restoration of the temple of Amon at karnak.a bull liaison lab points chausses N182,1992,P.
10. Massari, I. , Quelques aspects dela protection des monuments historiques contre L'humidite , La degradat et La conservation de la pierre , unesco.
11. Meyer.E. et al., a computerized solution for epigraphic surveys of Egyptian temples, Journal of archaeological science, V.33, issue11.
12. Prince, C. M., et al., the effect of sandstone micro Fabric upon relative permeability and points, Journal of petroleum science and engineering 24 (1999).
13. prince, C.M., et al., the effect of sandstone micro fabric upon relative permeability and points, Journal of petroleum science and engineering 24(1999).
14. Steacy,S.,et al., Damage mechanics model for fault zone friction ,CGJ, Geophysics. , Res. V.97, NBI 1992.

15. Tawfic S., History of architecture in ancient Egypt - Luxor ,Cairo ,1990.
16. Wiedmann, H., et al., pigments of the bust of Nefertiti compared with those of the Karnak talats thermo chemical, 382, Issues1-2, 2002.