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LIME STONE QUARRYING POLLUTION AND CONTROL (National Cement Company)

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ABSTRACT:

Helwan is a highly polluted city due to the presence of many activities such as Quarrying, Iron & Steel making. Garawi lime stone quarry, National Cement Company (NCC) which is located near the city of Helwan is selected to describe quarrying operations and to measure pollution levels. Quarrying operations including drill-blast technology and crushing were analyzed.

Further more, the environmental aspects were identified. Inhalable, thoracic and respirable dust in different aspects were measured using Haz Dust II. Dust concentration measurements have been compared with TLVs given in law number 4 for the year 1994.

Finally, control measures are recommended to reduce dust emissions and protect the environment in one of the main pollution sources near Helwan.

INTRODUCTION:

Cement Industry is a highly polluted business. Particulate emissions from this industry reached a value of 870 000 tons per year in 1968 from a total of 7.5 million tons[1].

For annual cement production of 1.5 million tons it is necessary to produce 4800 (1/1.05) i.e. 4500 tons of clinker daily. The raw materials needed per day equal 1.75×4500=7875 tons which need 9000 tons per day to be crushed. The raw materials include (75%) limestone and (25%) clays. Lime stones used should satisfy the requirements of different ratios such as the lime saturation factor, silica ratio, and alumina to iron oxide ratio[10].

The needed production of lime stone per day equals 9000 × 0.75 = 6750 tons. Such production necessitate the use of powerful drills, large dimension benches and impact crushers of large capacities. For the purpose of this paper, Garawi lime stone quarry belonging to the National Cement Company and Located near Helwan is selected.

The environment aspects of the mentioned quarry were identified and a highly developed instrument (Haz Dust II) was used to measure the dust concentrations.

The correlation between technology and pollution will help for the pre assessment of the environmental pollution due to quarrying operations.

This paper aims to;

1-Identify the environmental aspects of lime stone quarrying.
2-Analyze the technology used and compare it with the practice recommended by several authors and expertized companies.
3-Measure dust concentrations.
4-Recommend control measures to reduce dust concentrations and protect the environment.

INVESTIGATED QUARRY:

Garawi lime stone quarry belonging to the (NCC) and located near the city of Helwan is selected here. The key map location is shown in Fig.(1). The quarrying operations include drilling-blasting and crushing.

1-Drilling:

A powerful rotary drill (klem type) as shown in Fig. (2) is used to drill blast holes. Hole depth of 41 m and diameter of 152 mm are used. The drill specifications are given as follows,

Power = 58 kw
Rpm = 20–100
Pull down = 40 KN

Selection of a powerful rotary drill with the specifications mentioned above is highly appreciated and can be Justified using, the monogram shown in Fig. (3)[2].

2-Blast hole parameter:

The blast hole parameters which have been used in the mentioned quarry are; burden (6m), spacing (7m), sub drilling (1m), stemming length 2 m and total charge per hole (420 kg powder explosive). These parameters are tabulated in the last column of table (1). On the other hand Nitro Nobel company[3,4] recommended several formulas to estimate the blast hole parameters knowing the hole diameter. These recommended formulas are tabulated in the second column of table (1). The estimated values of blast hole parameters are given in the third column of table (1).

Table (1) indicates that there is no significant difference between applied burden and spacing in the mentioned quarry and the estimated values. However the sub drilling and stemming length approximately equal ½ the estimated values. This increases the charge length and consequently the charge consumption of explosives (420 kg/hole) against the estimated one 236 kg/hole. In addition quarry powder explosive is used in the mentioned quarry and gelatin sticks connected to a detonating fuse as primers, (Fig. 4).

Finally one can conclude that the drill blast parameters used in the mentioned quarry are in agreement with the Nitro Company practice based on Longefors, U. theory of rock blasting[3].

3-Crushing:

Twin and single impact crushers are used for crushing the blasted rock. The specifications of the twin type (KHD) are;

Production 1200 t/h
Feed 80×80 cm
Product size 3-5 cm

The production of the single type (D & K) and (Hishman) equals 1000 ton/h.

Lowirson, 1974[6] stated that large impact crushers reduce a size from 1.5 m R.O.M. to a product size of 20 cm at capacities around 1500 ton/hour. This means that the selection of impact crusher in the mentioned quarry with the mentioned capacity and reduction ratio is a good choice. Further more, Wils, 1985[7] stated that the impact crushers do not cause internal stresses like jaw crushers.

Table (1): Estimated and applied blast hole parameters

Item	Equation	Estimated parameters	Applied parameters
Maximum Burden (V_{max})	V_{max}=45 D (1)	6.85 m	Burden=6 m
Practical burden (V_1)	$V_1=V_{max} - F$ (2) $F=\frac{3D}{100}+\frac{3H}{100}$ D=diameter mm, H=hole depth m	5.15 m	
Spacing (E)	E >< 1.25 V_1 (3)	6.44 m	7 m
Sub drilling (U)	U=0.3 vax (4)	2.1 m	1 m
Stemming length (H_o)	$H_o=V_1$ (5)	5.15 m	2 m
Bottom charge consumption (I_b)	$I_b=\frac{\Pi D^2}{4} x PxS$ (6) P=density of explosive (0.75kg) dm^3 S=strength=0.76	10.33 kg/m	
Bottom charge height (h_b)	$H_b=1.3 V_{max}$ (7)	8.91 m	
Column charge concentration (I_c)	$I_c=0.4 - 0.6 I_b$ (8)	5.19 kg/m	
Column charge Height (h_c)	$H_c=H - h_b - H_o$ (9) H=K + U K=bench height	26.57m	
Total charge/hole (Q)	$Q=I_b \times h_b + I_c \times h_c$	230 kg/hole GD or 378 kg/hole powder.0.8 compaction	420 kg/hole powder

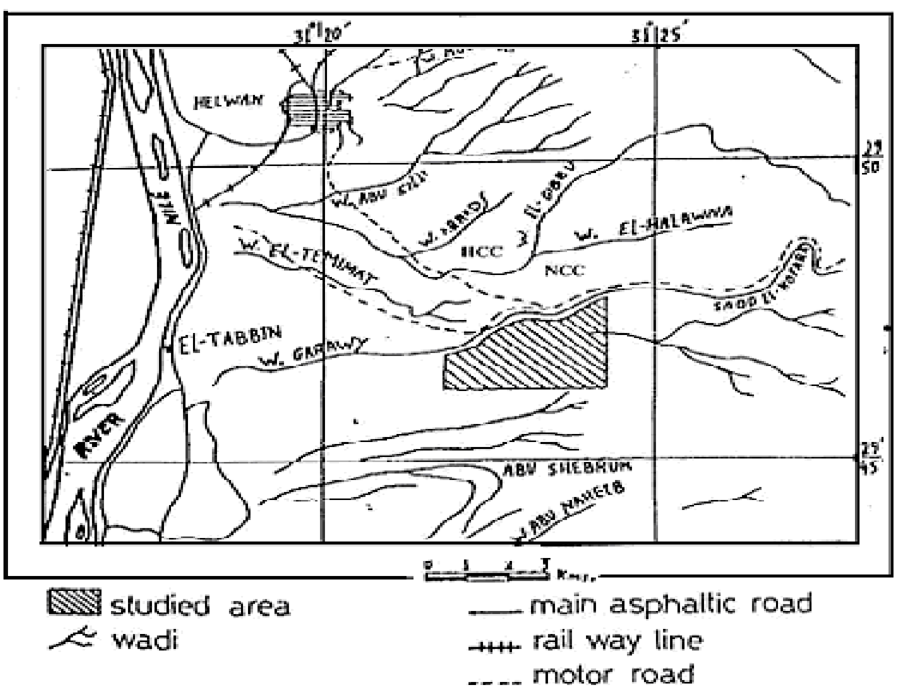

Figure (1): Key map location of Garawi Quarry (NCC)

Figure (2): The Rotary drill machine used at Grawai Quarry

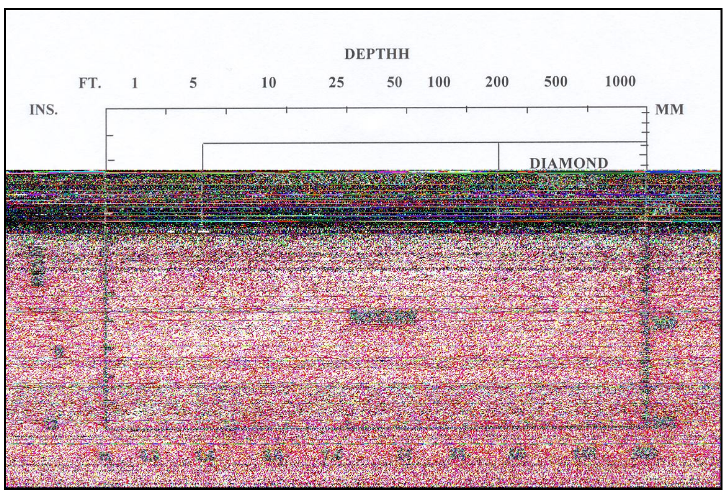

Figure (3): Preferred drilling method for different depth and diameters

Figure (4): Blast hole at Garawi Quarry (NCC)

DUST CLASSIFICATION:

Dust can be classified according to the balance of forces acting (Gravitational, buoyancy and drag forces) to suspended dust and fallen dust, particles.

Also, dust particles cause pulmonary diseases in the respiratory system of the human being. Fig. (5) gives the fraction deposited in the nose and throat regions (1), tubes leading to lungs (2) and lung regions (3)[8]. Consequently, dust can be classified into inhalable, thoracic, and respirable, as presented in Fig. (6).

ENVIRONMENTAL ASPECTS:

Environmental aspects of this quarry are due to drilling, blasting, and crushing operation.

It is impossible to measure the dust concentration at the areas close to the blasting operation. The crusher is enclosed under exhaust ventilation and only the dust releases from dumping the blasted rock at crusher mouth was measured.

MEASUREMENTS:

1-Instrument:

Haz dust II shown in Fig. (7) was used to measure dust concentrations. The principle of operation of this instrument is based on the scattering of infrared radiation by air born particles. The accuracy limite of this instrument are $\pm$ 10%.

The instrument is equiped with three sensors to measure the inhalable, thoracic and respirable dust. The size of inhalable dust particles ranges from 0 to 100 μm, with a cut point at 50% of 100 μm. The range of thoracic dust is from 0 to 25 μm and 50% cut point at 10 μm. The range of respirable dust is from 0 to 10 μm with a 50% cut point at 4 μm [9].

The instrument records the time weighted average (TWA), short time exposure limit (STEL), average, maximum, and minimum concentrations for each type in mg/m^3.

Measurements of the three dust types will help us to select control equipment.

2-Dust Concentration due to drilling:

Dust concentration measurements of inhalable, thoracic and respirable types are plotted vs. time as shown in Fig. (8).

The inhalable dust concentration reached a value of 200 mg/m^3 while thoracic reached a maximum concentration of 85.92 mg/m^3 and the respirable dust concentration reached 21.02 mg/m^3. On average dust concentration of inhalable (92.11 mg/m^3) exceeds the average of the thoracic (49.99 mg/m^3) and respirable (8.09). The increase of inhalable dust concentration than other types is expected as the inhalable size range includes both thoracic and respirable.

3-Dumping at crusher mouth:

The inhalable dust concentration reached a maximum value of 31.15 mg/m^3 while thoracic dust concentration reached a maximum of 53.49 mg/m^3 and the respirable reached a maximum of 4.23 mg/m^3 see Fig. (9). This results is attributed to the turbulence created due to dumping operation itself. On average the thoracic reached 43.4 mg/m^3 exceeding the average of both inhalable and respirable. This results is attributed to the balance between the gravitational, drag and buoyancy forces.

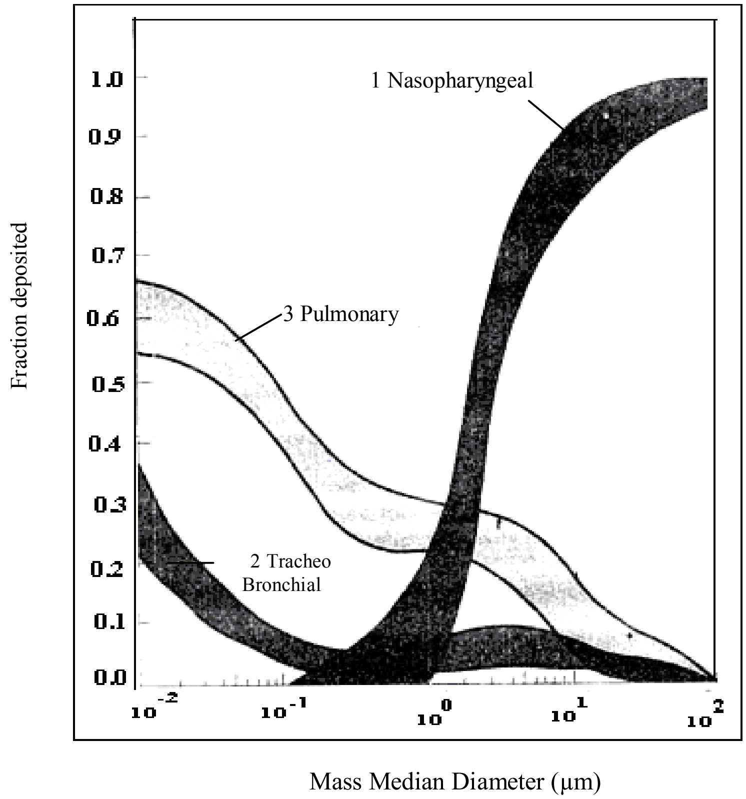

Figure (5): Aerodynamic deposition of particles by size in the respiratory tract[8]

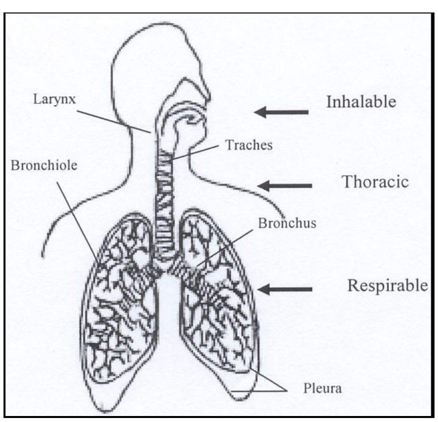

Figure (6): Inhalable, thoracic and respirable dust[9]

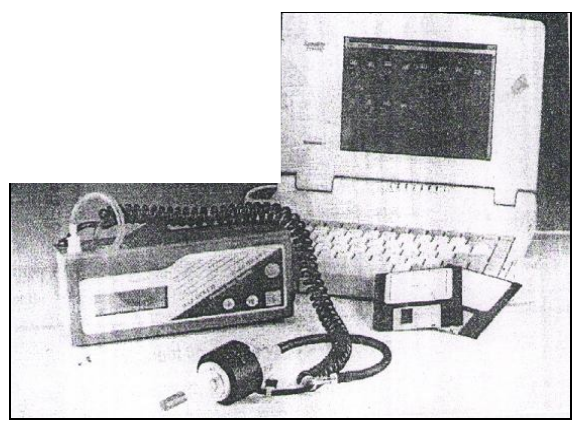

Figure (7): Haz Dust II instrument[9]

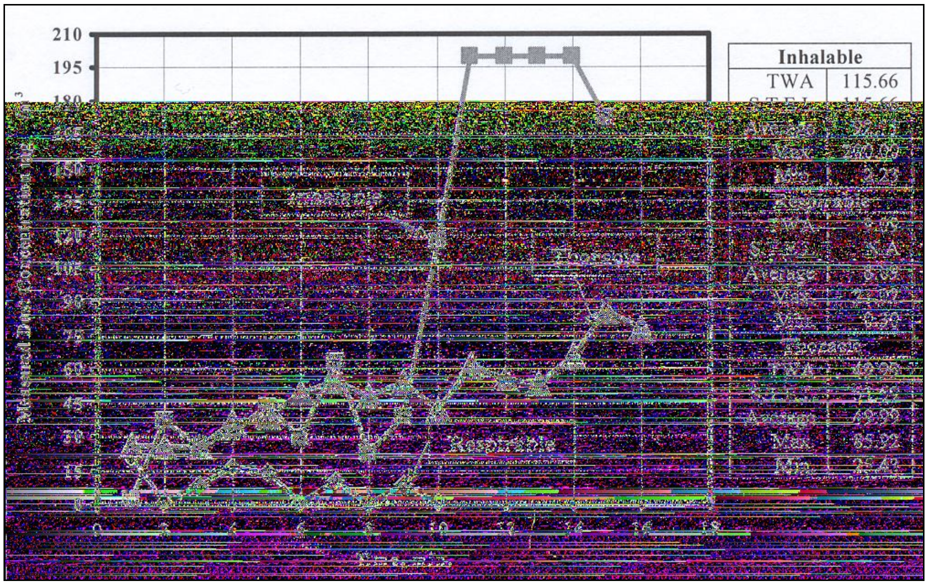

Figure (8): Dust Concentration vs. time (Rotary drilling)

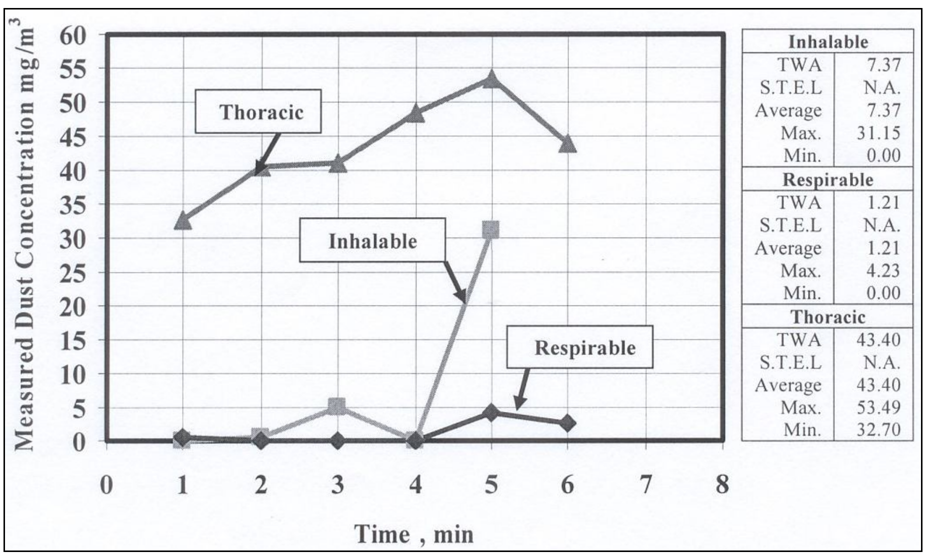

Figure (9): Dust concentration vs. time at the dumping station

4-The Admitted Values of Dust Concentrations:

The recommended formulas given in appendix 8 of the law number 4 for the year 1994[5] (limestone) are retabulated in table (2). The admitted values of the total and suspended dust are calculated and given in the mentioned table.

Table (2): Admitted Values of Limestone Dust Concentrations

Dust Type	Formula	Admitted Value
Total	$\frac{30\ mg/m^3}{\%\ of\ quartz + 3}$	$\frac{30}{3+3} = 5\ mg/m^3$
Suspended	$\frac{10\ mg/m^3}{\%\ of\ quartz + 2}$	$\frac{10}{3+2} = 2\ mg/m^3$

CONCLUSIONS AND RECOMMENDATIONS:

1-Drilling:

The average dust concentration of the inhalable dust equals 92.11 mg/m^3 while the average dust concentration of the respirable dust is 8.09 mg/m^3, see the attached table given in Fig. (8). The mentioned value of the inhalable dust exceeds the admitted value of the total dust; Also the average dust concentration of the respirable dust (8.09 mg/m^3) exceeds the admitted calculated values.

2-Dumping:

The average dust concentration of the inhalable dust equals 7.37 while the average dust concentration of respirable fraction is 1.21 mg/m^3, see the attached table given in Fig. (9). The mentioned values of dust concentrations for the inhalable and respirable fractions are within the limits.

Finally, the drilling equipment should be equipped with a dust collector.

REFERENCES:

1-El Hage, C. Reconstruction and privatization of the steel industry as a source of economic value improvement, UNIDO, Cairo, October, 1997.

2-Mc George, K. The drilling of rock, A Maclaren Company, London.

3-Nitro Company “Advanced Course in Blasting Techniques,” Blasting Techniques Department, Sweden, 1987.

4-Lange fors, U. Rock blasting, John Wiley & Sons, New York, 1973.

5-Law number 4 for the year 1994. Cairo 1998.

6-Lowirson, G.C. Crushing and Grinding, Butter Worth, London, 1974.

7-Wils, B.A. Mineral Processing Technology, Pergomen press, oxford, 1985.

8-Henry, J. *et al.* Environmental Science and Engineering, 2nd edition, Prentic Hall, New Jersy, 1996.

9-"Technical report", users Guide Manual HAZ DUST II monitor technical catalogue, Harver Hill, U.S.A.

10- هانى عبد الرحمن مكرم - تكنولوجيا صناعة الأسمنت القاهرة 1994.

11-Nasr-Allah, M. "The Environment indices of Air Pollution in Helwan Zone", J. Chem. 45, No. 1, (2002).

12-Abd El-Rahman, A. A., "Effect of chemical Dust suppressants on Milling operation of Minerals" the 9th International Mining.

التلوث الناتج من محاجر الحجر الجيري
(الشركة القومية للأسمنت)

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يتناول البحث دراسة مستوى التلوث بالغبار العالق فى الهواءو الناتج من بعض المحاجر والمناجم المصرية بغرض الحفاظ على البيئة نتيجة عمليات الحفر والتفجير ومن الكسارات وتعيين مستويات التلوث الناتجة. وتم تصنيف الأتربة المتولدة من العمليات المتجمعةبناءً على العوامل المؤثرة على حبيبات الأتربة، والذي يقسم الأتربة الناتجة إلى عالقة ومتساقطة، وكذلك تم تصنيف الحبيبات العالقة إلى Respirable, Thoracic, Inhalable، وذلك لتأثيرها على الأجزاء المختلفة للجهاز التنفسى.