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HEALTH IMPACT ASSESSMENT OF COMMERCIAL ROCK BLASTING: A STUDY OF THE JULIUS BERGER QUARRY IN MPAPE (AN AREA HIGHLY CONCENTRATED WITH QUARRY SITES) IN ABUJA

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Abstract - Industrial activities carries with it problems which are major considerations in Environmental Impact Assessment; stipulations are made to ameliorate the likely influence of such activities on the environment. This research work was done to evaluate the impact of Quarrying on the inhabitants of Mpape an area highly concentrated with quarry sites. The result from the analysis carried out shows that, despite the economic importance of quarrying activities to the growth and development of any country's economy, the dire consequences of quarrying to the immediate environment, to the health of the principal populaces around such quarry site, and to the health status of the workers directly exposed to the vagrancies from quarrying should not be overemphasized.

I. INTRODUCTION

Quarrying can be defined as the blasting, breaking, crushing, cutting, grading, and washing of rocks for desirable economic purposes (Nwachukwu, 2000). Quarry is a type of open- pit mining from which rock or minerals are extracted, quarries are generally used for the production of building stones, dimension stones, construction aggregates, ripraps, sandstone and gravels (Goldberg, 1972).

Man's search for development carries with it problems which are not in oblivion (Udoh, 2003), complaints resulting from Quarrying activities dates back to 1890's. The issues of concern include visual intrusion, damage to landscapes, traffic, smoke, noise effects, dust, creation of caves, loss of land, and deterioration in water quality. Of major concern is blasting which is necessary to break down the rocks from the ground for subsequent processing into aggregates. Environmental safety laws and edicts have been adopted by governments of nations of the world in order to protect the environment from such hazards. However, operators of quarries have abused these laws in order to maximize profit; the abuse is paramount in virtually around the Developing countries; including Nigeria and other African countries.

As part of our responsibility as academia to the communities, it is important not to overlook such problems during the course of a scientific research and community development work. The aim of this research work is to bring forth the scientific evidences to the reason why the hazards are being recorded in the village and to call the attention of the government to it. This paper work is also done in order to call to attention of the general public about the economic and dire consequences of quarrying to the environment and to the health of the quarry workers.

Despite the obvious benefits of quarrying, there are concerns that exposure to quarrying by-products could

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be detrimental to the human health. In particular, these concerns focus on inorganic and microbial components of quarrying that affects the human health.

In the definition of the term "QUARRY" from its definition above, the enlisted operational facets in quarrying is solely responsible for the emission of airborne effluents which leads to health complications of the workers, and the immediate populaces of the Mpape community where quarrying activities is at its peak.

Problem Formulation

Detailed information were retrieved based on the importance of quarrying to the country's economic growth, and also the effect of hazardous airborne effluents generated during the course of quarrying which at the long run is hazardous to the health of the workers and to the general public of the Mpape area.

Although many quarrying studies focused only on methods and models that would be of great importance for an effective quarrying process but limited information were made available on personal exposure to airborne effluents associated with specific tasks in the quarrying field.

Theoretical Framework

The activities by the operator of the Quarry in Julius Berger Nig Plc in Mpape village has adversely affected the villagers, their health standard have been compromised, their abode endangered, and their primary means of livelihood (farming) jeopardized. The government at both the local and state level should investigate the activity of this operator and others in this area, review/re-evaluate their (EIA) and appraise their activity and also that of the health status of the operational workers in the Berger quarry site and other quarry site in the Mpape community. The settlers should be relocated and compensated appropriately. It is recommended that a detailed Environmental Impact Assessment should be carried out before Quarrying License can be obtained from government; a task force should be set up by the government to investigate operators that are not complying with Environmental regulations or code of Practice for Quarrying activities, offenders should be prosecuted. A modality should also be agreed upon by both inhabitant and government of a proposed quarry site. The interest of the locals should be considered objectively during issuance of license and monitoring activity by the government. And the government task force team should be composed of a geologist, engineer, environmentalist, surveyors, and a team of medical experts.

Aim and Objectives

The aim of this work is to investigate the environmental and health implications of the Mpape quarry site on the surrounding areas and to humans directly involved as workers in the industry. This aim has the following objectives:

1. To map out the location of the Julius Berger Quarry in Mpape.
2. To assess the health implications of the industry on the people directly employed to work in the company.

Justification of the Study

In quarrying, as in other industries where workers may be exposed to large concentration of organic dust, there are reported evidences mainly from studies carried out in Mpape where most companies quarrying site including that of JULIUS BERGER is located that there is an increased level of airborne disease, antibodies, and inflammatory respiratory pathogenic bodies associated with quarrying (Rong Zhang and Thomas L. Delworth, 2006). As with other industries where workers are exposed to organic and inorganic dust, fumes, and mist, there is the potential for an intense progressive respiratory ill-health with continued exposure (Ejike, 1989).

With quarrying on a major scale, it's relatively new and rapidly expanding in the commercial business terrain simultaneously with symptoms of chronic health problems which may not be detected during the period of the workers active services years or periods, although there may be justifications in long term health monitoring of the workers' health phase (Adeyemo, 1999).

Concerns has been raised by residents in and around the vicinity of the quarrying parameters; stating that the activities carried out specifically and collectively in the quarry-sites have increased the level of **Bio-aerosols** such as airborne *Aspergillum fumigates* spores and **Aerosols** such as airborne *Pneumonocoisis Spp* in the past three (3) years. Thus, it is necessary to investigate the problem of dust emission on the workers while still in service so as to checkmate negative health consequences in the future.

Scopes and Limitations

This study is expected to cover all the prevalent health challenge associated with quarrying activities. The minute information gotten during this paper work tends to be a sort of limitation that hinders the analysis of the problem caused by the acts of quarrying.

Study Area

Mpape lies within **Latitude**: 9º 9′30″N, 9º 7′0″N and **Longitude** 7º 28′30″E, 7º 30′30″E, with central time zone of Africa/ Lagos. It experiences Sunrise at 0633am and Sunset at 1840pm. Mpape, a town surrounded by rocks, is a satellite settlement in Abuja, located at the eastern part of the capital city. It is about a twenty minutes' drive from Berger junction in which commercial vehicles charge N50 per person going to these area. Mpape is a hill in the region of the north-west of the country's capital, with an average elevation of 4,124 feet above sea level. The location is sparsely populated with 3 million people per mile[2].

Natural Hazards

Mpape can have low impact or less average earthquakes (on average of one for every 50 years), with occurrences at (<5 Richter). When an earth quake occurs, it may be felt indoors by many and outdoor by few during the day. At night, some people may be awakened. There is a medium-low occurrence of periods with extreme drought. Flooding risk is low. The occurrence of quakes in Mpape could be asserted to the fact that, there is a high concentration of Quarrying companies.

The Topographical Configuration

The terrain of Mpape is a rugged and hilly type, this alone is the determining factor for the localization of over 6 quarry sites including the Julius Berger Quarry Site. Considering that Mpape is surrounded by rocks, some companies like Julius Berger, Crush Rock, Arab contractors and Setreco finds it conducive for their location. Mpape is surrounded by abundant hills, highlands, Savannah grassland, and tropical rainforests. However, the unfortunate reality of Mpape even though it is an industrial center is that the idealistic vision of the area was not backed by solid planning. Less than 14 years after its completion, there are slums and squatters settlements in the midst of industries and homes, occupied by the average and less fortunate even though Mpape was not created to act as a residential site.

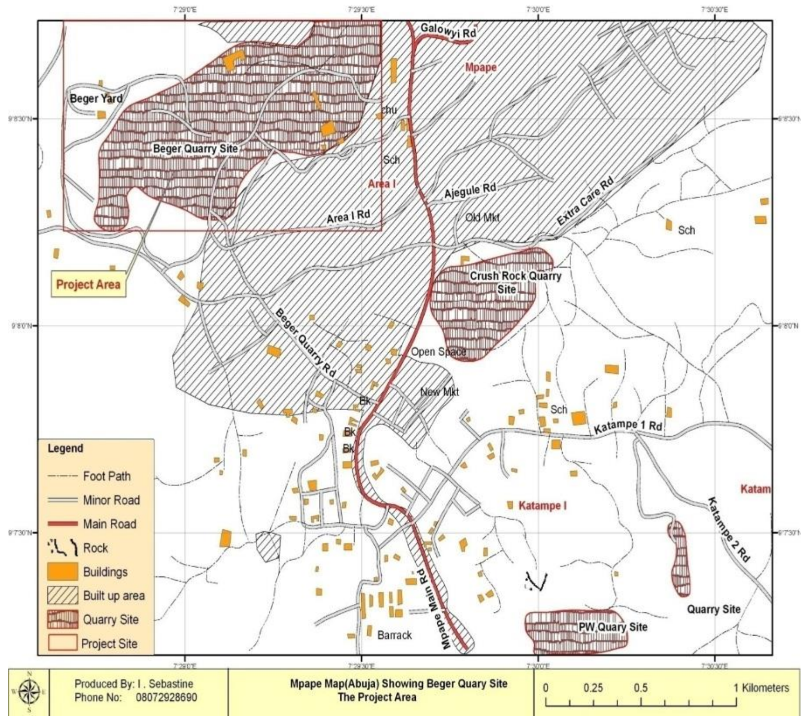

Fig 1: Showing the Study Area Including the Julius Berger Quarry Site in Mpape Abuja

II. LITERATURE

BLASTING

Rock blasting is the controlled use of explosives and other methods such as gas pressure blasting pyrotechnics or plasma processes, to excavate, break down or remove rock Persson *et al* (1994:1). It is practiced most often in mining, quarrying and civil engineering such as dam or road construction. Except in mining, the result of rock blasting is often known as a *rock cut*.

The use of explosives in mining goes back to the year 1627, when gunpowder was first used in place of mechanical tools in the Hungarian (now Slovakian) town of Banská Štiavnica. The innovation spread quickly throughout Europe and the Americas. Rock blasting currently utilizes many different varieties of explosives with different compositions and performance properties. Higher velocity explosives are used for relatively hard rock in order to shatter and break the rock, while low velocity explosives are used in soft rocks to generate more gas pressure and a greater heaving effect Persson *et al* (1994:1).

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BLASTING IN SURFACE EXCAVATION

Any blast optimization program calls for a clear understanding of the effects of principal blast parameters and their careful applications. The degree of fragmentation of rock depends on:

a. the rock's characteristics;
b. the properties and quantities of explosives;
c. blast geometry;
d. blast size;
e. the priming method; and the initiation sequence.

Terminology in bench blasting

Free face: This is an exposed rock surface like a wall towards which the explosive charge can break out.

Face height (H): This is the vertical distance in meters between the top and floor of the bench and should be at least twice the burden.

Blast hole diameter (D): Generally, the cost of drilling and blasting decreases as hole diameter increases. The relation between blast hole diameter and face height is approximately:

D = 0.001 to 0.02 H

Burden (B): This is the distance in meters from a blast hole to the nearest free face and has the following approximate relation:

B = 25D to 40D
Or B = 25D to 30D for hard rock
B = 30D to 35D for medium rock
B = 35D to 40D for soft rock

Spacing (S): This is the distance in meters between adjacent blast holes and is measured perpendicular to the burden.

Usually the relation between drilled burden and spacing is:

S = 1 to 1.8B

The above definition is best illustrated in Figure 2.1

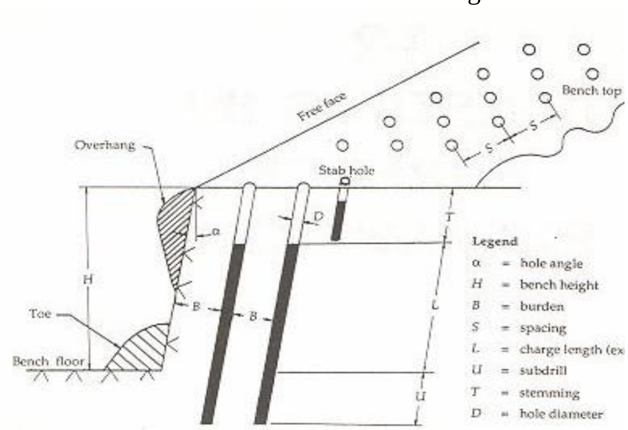

Fig 2. Surface Blasting Terminologies.
(Source: Mantyloso, and Vouri, 1984: Effect of Impulse Noise and Continuous Steady-state Noise on Hearing).

Hole angle (α): If the strata conditions permit, inclined blast holes allow better distribution of the explosives. Inclined blast holes are very effective in eliminating 'toe' (which is a hump of solid rock between the free face and the bench floor), and back break, varies between 0 degrees and 30 degrees from the vertical plane.

Sub drill (sub grade drilling or over drilling) (U): This is the extra depth drilled below the grade level to assure that the full face of the rock can be broken to the desired excavation level. Usually U= 8 to 12D; alternatively it equals to B/3.

Charge length (L): This is the explosive column in a blasthole and should be at least 20D in order to utilize fully the explosion-generated strain in the rock.

Stemming (T): This is the inert material filled between the explosive charge and the collar of the blast-hole to confine the explosion gases.

The stemming material could be water, drill cutting, sand, and mud or crushed rock. The best is the dry angular crushed rock (<30mm) as it tends to form a compaction arch, which locks into the blast-hole wall, increasing its resistance to ejection. The optimum stemming length can be found from the following formula:

$$T_s = \frac{12Z}{A}\left(\frac{QS}{100}\right)^{1/3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

Z = Fly rock factor (1 for normal blasting and 1.5 for controlled blasting
A = Rock factor (6 for very soft and 14 for hard rock
Q = Mass (kg) of explosives in 8 hole diameters or if the charge length is less than 8 hole diameters, the total mass of explosives.
S = Relative weight strength of explosives (ANFO) = 100

A stemming length shorter than 20D usually causes fly rock, cut-offs and over break problems. It is also suggested that the stemming length should not be less than the effective burden B.

The relationship between the explosive powder ratio to certain rock characteristics is briefly illustrated in Table 1

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Table 1: Guide to powder factors and rock factors for various rock types **(Source: Mantyloso, and Vouri,**

General Category	Rock type	Powder factor (kg/m3)	Rock factor A
Hard (+200)	Andesite Dolerite Granite Ironstone Silcrete	0.70	12-14
Medium (100-200)	Dolomite Hornfels Quartzite Serpentinite Schist	0.45	10-11
Soft (50-100)	Sandstone Calcrete Limestone Shale	0.30	8-9
Very soft (-50)	Coal	0.15 – 0.25	6

1984: Effect of Impulse Noise and Continuous Steady-state Noise on Hearing)

Back-break or over-break: This is when the rock mass behind the row of blast-holes farthest from the face is broken or cracked. Back break is an undesirable phenomenon because it makes the crest of the face unsafe and often presents problems in drilling the first row of holes for the next blast.
Decoupling ratio can be defined as the ratio of the diameters of an explosive column and the blast hole and is usually expressed as a percentage.
For example, if an 88 mm diameter hole is charged with 64 mm diameter cartridge.
The decoupling ratio ($Rd\frac{64}{88} \times 100 = 73\%$.)

Blast Hole Patterns:

1. Square versus staggered pattern
Blast holes can be drilled in either square pattern or staggered pattern.
A staggered pattern produces a more uniform distribution of explosive effect.

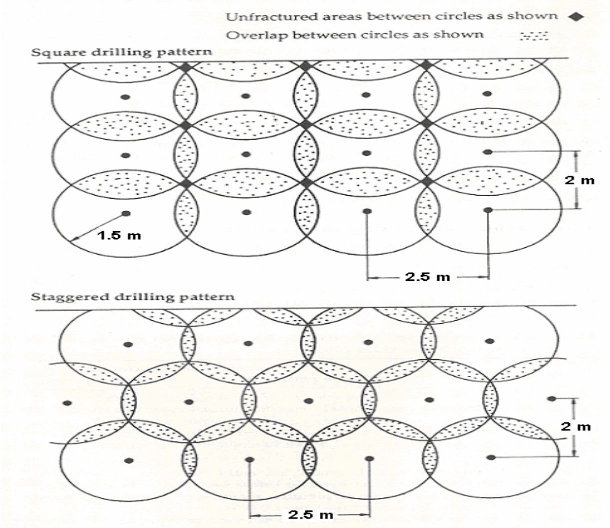

Fig 3: Square versus staggered pattern. Optimum coverage is achieved in staggered pattern.

Optimum fragmentation can be achieved by firing each blast hole separately by using (Figure 3) trunk line delay (TLD) system units on the surface.
This system has particular application where ground vibration problems put restrictions on the charge mass detonated per delay.

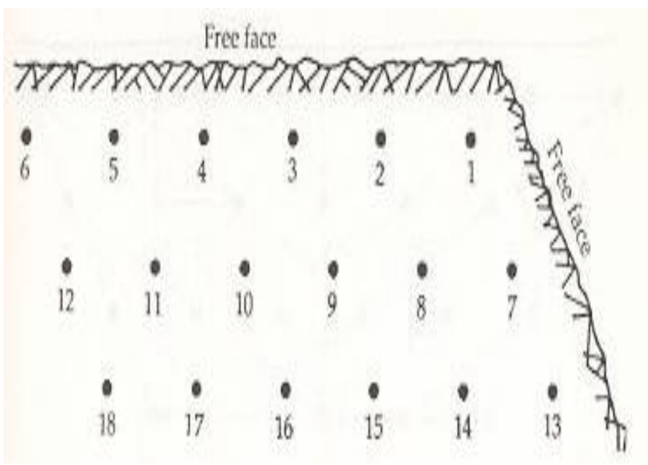

Fig. 4 Trunk Line Delay System.

Chevron patterns:
A closed chevron pattern produces a high profile rock pile with a possible secondary fragmentation due to impacts between rocks projected from opposite directions. An open chevron patterns gives evenly spread rock piles particularly suitable for front-end loaders and may produce less toe problems.

Firing Patterns
In normal blasting all holes do not blast at the same time. Bench blasting is normally carried out as short delay blasting. The firing pattern has to be designed so that each blast hole has free breakage. The firing sequence of a chevron pattern can radically alter the drilled burden and spacing into the blasted or effective burden (Be).

Delay Intervals
Too short a delay causes the back rows to be initiated before the burden on the front holes has time to break away and to move. This may cause flyrock from rows at the back. Too long a delay may also cause flyrock, airblast and boulders, as the protection from previously fired rows disappears due to too great a rock movement between detonations (Vouri, 1984).

Blast Size
The blasted block should be such that the length is at least twice the width and preferably five times or more. As the number of rows of blast-holes increases, the overall rock fragmentation improves, usually up to 5 rows. However, if the loading equipment can handle a high profile of broken rocks the number of rows can be increased to about 8.

Blast Design
The best use of explosives is made when a blast produces a clean break, giving good fragmentation, while avoiding excessive fly-rock. The success of achieving these goals depends significantly on good blast design.
If the blast-holes are drilled as a staggered pattern on an equilateral triangular grid, the optimum distribution of the explosive's energy is achieved.

a. Secondary Blasting

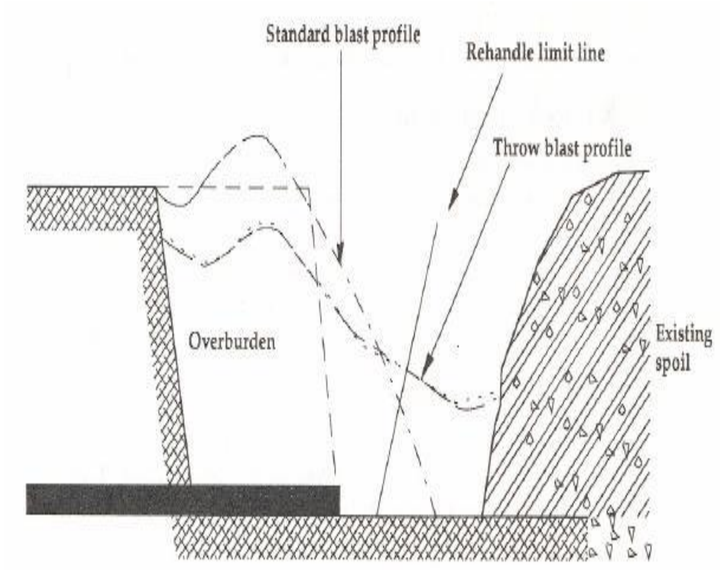

Fig 5: Standard Blast Versus Throw Blast Profile Persson *et al*, (1994:1).

Most primary blasting, whether on surface or underground, will leave some oversize boulders.
The term oversize boulder may be defined as any boulder produced from primary blasting, which cannot be adequately handled by the standard loading and crushing equipment used in an operation. Its size varies from one operation to another, depending on the type of loading, conveying and crushing equipment in use.
In surface mining or quarrying, oversize boulders cause delays in loading operations. Boulders or oversize rocks have to be lifted out of the muck pile during digging and set aside for secondary breakage.
In underground mines oversize may cause hang-ups in the chutes and orepasses. Oversize rocks may be broken by hydraulic impact breakers or drop balls. In smaller surface mines or quarries it is not economical to use these machines, so explosives have to be used.
However, secondary blasting is the most expensive type of blasting. Appropriate blast design is important in order to lessen the production of over size.
Secondary blasting can be done by pop shooting (block holing) and plaster shooting (mud capping).Shaped charges are sometime used in secondary blasting, but this is much more expensive Persson *et al* (1994:1).

b. Cast Blasting
When overburden is removed from a coal or mineral deposit it is generally cast to a waste dump by draglines, or removed by loaders and trucks.

Cast blasting is the controlled placement of overburden into the previously mined cut resulting in a reduced volume, or overburden material for the dragline to handle.
Cast blasting often results in improved fragmentation of the overburden material, causing improved productivity for the dragline or loader. This type of blasting is sometimes called throw or controlled trajectory blasting.

III. RESEARCH METHODOLOGY

This section is designed to outline the various methods and approaches that will be used to conduct the research work. A framework is thus established for the analysis of data. This section has been divided into sections, each describing their contents which includes: Research Population, Data Collection, and Reconnaissance Survey

Reconnaissance Survey

This is the preliminary survey carried out in the study area, this was done to ensure familiarity with the general characteristics of the study area. This survey was carried out under time duration of four (4) months; this was done in order to get a comprehensive knowledge of what is obtainable in the area.

Data Collection Techniques and Analysis

The data below are sets of data collected from the Blasting section of the Quarry site of the Julius Berger Quarry Site in Mpape, Abuja, Nigeria. The data set were collected from the Julius Berger Health Facility (***SECONDARY***) sources, and also based on some few moments of discussion/interview with the workers (***PRIMARY*** mode of data collection) in the site during my 4 months SIWEs (Internship Program as an Environmentalist) program. The data below were analyzed using the Analysis of Variances (ANOVA) techniques, reason was that; the data are parametric in nature, and because they involve population samples of over 500 workers (of different shifts).

A one-way analysis of variances and graphical representation of data with mean plot were used in the analysis of data gotten from all facets of the quarry site.

Also, this data were generated based on the platform of ***Reoccurring diagnosis/ Bay visitation*** of ailing workers from all sites/workshops in the quarry site.

Hypothesis Verification

Ho: There is no significant variation if (Significance figure) $P>\alpha$ (0.05)

H1: There is significant variation if (Significances figure) $P<\alpha$ (0.05)

IV. DATA PRESENTATION AND ANALYSIS

Table 2 Tabular representation of Ailments from the Blasting Session (Source: Julius Berger Health Facility, 2011)

Year	Cold/flu	Asthma	Pneumonia	Bronchitis	Silicosis	Lung Cancer	Tuberculosis	Death	TOTAL
2005	21	5	9	12	9	0	0	0	56
2006	11	2	10	11	14	2	0	0	50
2007	13	2	11	9	8	3	3	1	50
2008	19	5	11	17	11	1	5	2	71
2009	26	2	9	8	18	1	6	1	71
2010	10	17	13	14	12	3	7	0	76
TOTAL	100	33	63	71	72	10	21	4	**374**

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		Sum of Squares	df	Mean Square	F	Sig.
Cold/flu	Between Groups	411.81	5.00	82.36	4.16	0.01
	Within Groups	594.50	30.00	19.82		
	Total	1006.31	35.00			

Table 3 Variation of Cold/flu within the Blasting Section

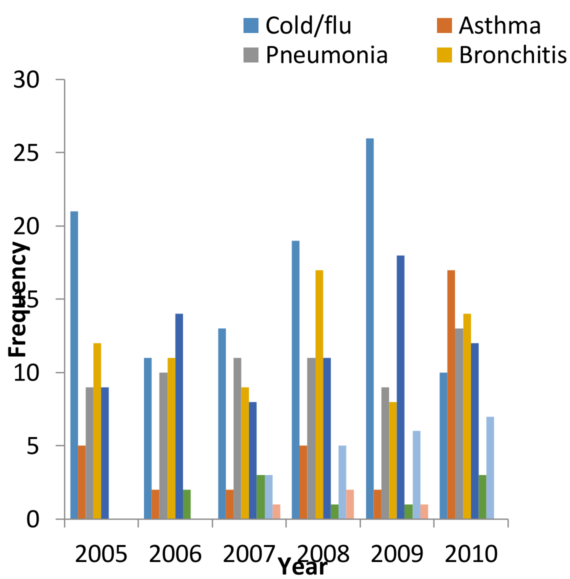

Fig 6. Compound Bar-Chart showing Analyses of Data from the Blast Session.

Variation of Illnesses within the Various Facets at the Julius Berger Quarry Site Mpape

There is a significant variation of Cold/Flu within various Facets.

The result revealed that since $p<0.05$ alpha (α) levels from (Table 3) it implies that there is a significant variation of Cold/Flu with sites/workshop. The null hypothesis (H_0) is therefore rejected and an alternative hypothesis adopted. Dust is the main causative of Flu and Cold, and as we know the by-products in all quarry sites are mostly dust.

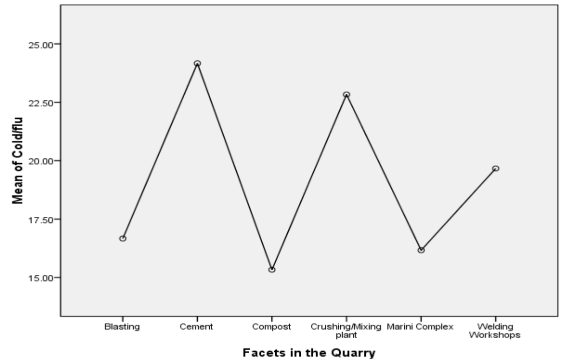

Fig 7 Mean plot of cold/flu variation within the Blasting Section of Quarry.

From the mean plot it entails that cold/flu cases is high in the cement and crushing plant, with the welding workshops having a middle representation, and the with a significant low account in the **Blasting**, composite and the *marini* plant.

		Sum of Squares	Df	Mean Square	F	Sig.
Asthma	Between Groups	240.14	5.00	48.03	5.17	0.00
	Within Groups	278.83	30.00	9.29		
	Total	518.97	35.00			

The result revealed that $p>0.05$ alpha (α) levels from (Table 4). This implies that there is a significant variation of Asthma within the Blasting Section. This further implies that there is variation of ailments within the Blasting Section, and that some facets exerts some specified ailments to workers that are exposed to such pathogens that might likely cause the emergences of such ailments.

Fig 8. Mean plot of Asthma variation within the Blasting Section in Quarry

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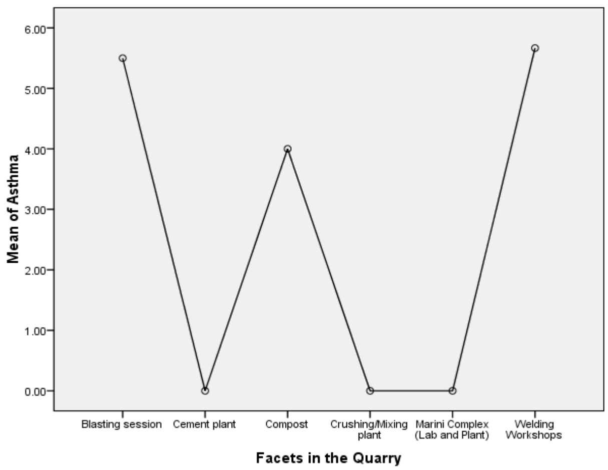


The incidences of Asthma tend to be extremely high in both the **blasting** and **welding** aspect of the quarry, followed by the **compost** although this ailment tends to be triggered by seasonal variation of the climatic condition during the year in the quarry.

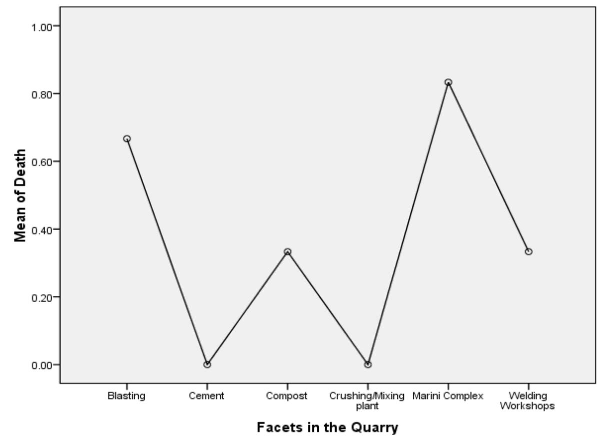
Table 5: Variation of Death within the Blasting Section

		Sum of Squares	Df	Mean Square	F	Sig.
Death	Between Groups	3.47	5.00	0.69	1.24	0.32
	Within Groups	16.83	30.00	0.56		
	Total	20.31	35.00			

There is no significant variation of Death within various Facets.

The result revealed that $p<0.05$ alpha (α) levels from (Table 5). This implies that there is no significant variation of Death within the Blasting Section. The null hypothesis (H_0) is therefore accepted.

Fig 9. Mean plot of Death variation within the Blasting Section in Quarry.



Death variation among various facets is not subjective to the workers life-span because, death cases might occur as a result of accidents, or from long or short term effects of continuous exposure to aerosols or bio-aerosols present in the quarry.

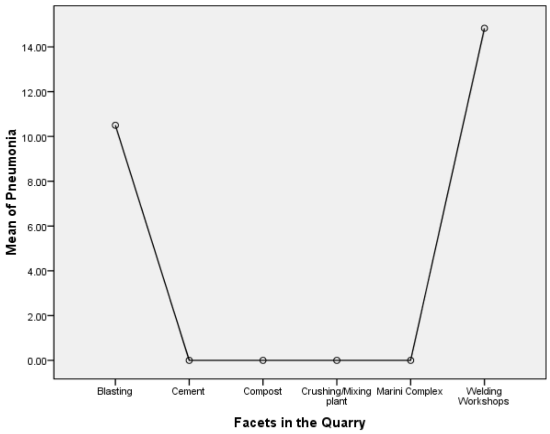
Table 6: Variation of Pneumonia within the Blasting Section.

		Sum of Squares	Df	Mean Square	F	Sig.
Pneumonia	Between Groups	1339.89	5.00	267.98	59.85	0.00
	Within Groups	134.33	30.00	4.48		
	Total	1474.22	35.00			

There is a significant variation of Pneumonia within various Facets.

The result revealed that $p<0.05$ alpha (α) levels from (Table 6) implies that there is a significant variation of Pneumonia within the Blasting Section. The null hypothesis (H_0) is therefore rejected and an alternative hypothesis adopted that there is a significant variation of Pneumonia within the Blasting Section.

Fig 10. Mean plot of Pneumonia variation within the Blasting Section in Quarry.



This entails that air-borne pathogens which affects the respiratory tracts there-in leading to the case of Pneumonia are mostly found in the **cement** and ***marini*** complex of the quarry.

Table 7: Variation of Lung Cancer within the Blasting Section

		Sum of Squares	Df	Mean Square	F	Sig.
Lung Cancer	Between Groups	13.33	5.00	2.67	9.23	0.00
	Within Groups	8.67	30.00	0.29		
	Total	22.00	35.00			

There is a significant variation of Lung Cancer within various Facets.

The result revealed that $p<0.05$ alpha (α) levels from (Table 7). This implies that there is a significant variation of Lung Cancer within the Blasting Section. The null hypothesis (H_0) is therefore rejected and an alternative hypothesis adopted that there is a significant variation of Lung Cancer with sites. This implies that not all sites/workshops create an atmosphere where carcinogens are emitted.

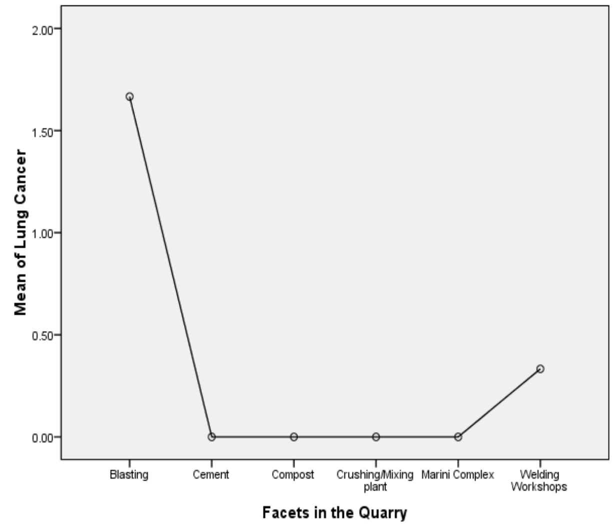


Fig 11. Mean plot of Lung cancer variation with sites/workshops in Quarry.

The case of lung cancer tends to be high in the **cement** plant and then following suit in the welding workshops and then by the zero (0) variation in other sites/workshops. Thus, we can say that workshops/site exert ailments on workers too.

Table 8: Variation of Bronchitis within the Blasting Section

		Sum of Squares	Df	Mean Square	F	Sig.
Bronchitis	Between Groups	700.14	5.00	140.03	76.61	0.00
	Within Groups	54.83	30.00	1.83		
	Total	754.97	35.00			

There is a significant variation of Bronchitis within various Facets.

The result revealed that $p<0.05$ alpha (α) levels from (Table 8). This implies that there is a significant variation of Bronchitis within the Blasting Section.

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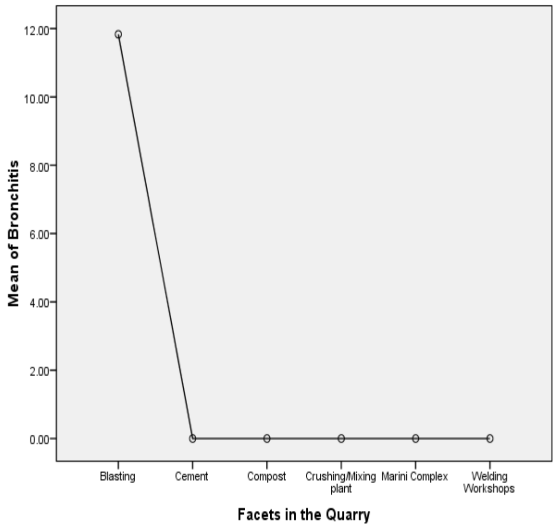

Fig 12. Mean plot of Bronchitis variation within the Blasting Section in Quarry.

Cement plants tends to have the highest case incident of Bronchitis disease, as such it reveals that the case of bronchitis is solely caused by the dust from the **cement** plant.

Table 9: Variations of Silicosis in Blasting Section

		Sum of Squares	Df	Mean Square	F	Sig.
Silicosis	Between Groups	720.00	5.00	144.00	65.46	0.00
	Within Groups	66.00	30.00	2.20		
	Total	786.00	35.00			

There is a significant variation of Silicosis within various Facets.

The result revealed that $p<0.05$ alpha (α) levels (Table 9). This implies that, there is a significant variation of Silicosis within the Blasting Section and it is most significant in cement plant of the quarry site. The null hypothesis (H_0) is therefore rejected and an alternative hypothesis adopted.

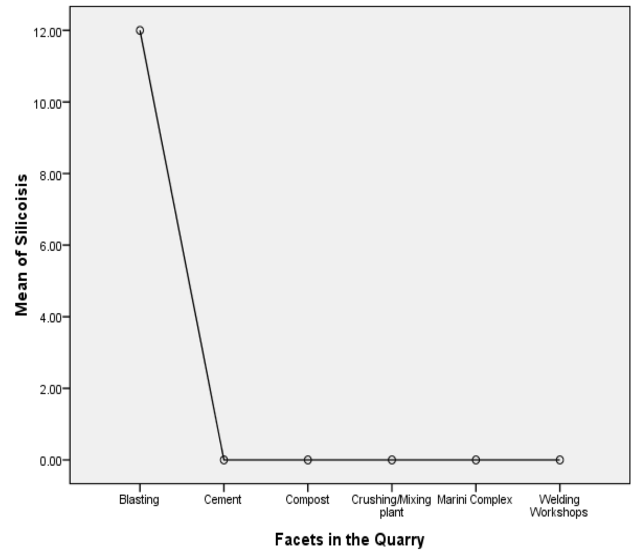

Fig 13. Mean plot of Silicosis variation within the Blasting Section in Quarry.

Silicosis is a kind of occupational health complications that tends to be caused as a result of intense inhalation of dust of silicon from cement and other product of limestone. Silicosis tends to be high in the **cement** plant of the Quarry because of the presences of these causative pathogens.

V. CONCLUSION

Most governments have some form of hazards communications standards. These include some form of labeling of dangerous chemicals to enable the users to quickly identify the hazards of the products. Some countries use risk-based labeling, others use hazard-based labeling. There is no generally specific way of classifying hazards to chemicals. However significant progress has been made recently in the form of "Global Harmonization of Systems for classification of Chemicals (GHS)". This is a UN backed initiative aimed at a common approach to classification. This ultimately will combine all the different ways of classifying dangerous chemicals into a single standard which will then be available as a model for adoption by national and regional government. Hazard communication to the chemical users is through regulations which vary quite a lot between countries. For example, in the US the standard is 25CFR1910; this is very different from the system used throughout Europe under the Dangerous Substance Directive (67/584/EEC), and the Dangerous Preparations Directive (1999/45/EC).

Categories of Danger

There are some basic threads of commonality regardless of the differences between different regions of the world. There are (3) general groups of chemical hazards, each of which contains a number of sub-classifications:

- **Physiochemical effects:** those that are caused by the intrinsic physical or chemical properties of the substances; for example flammables, oxidizing, and explosives.
- **Health effects:** those that arise from a chemical causing harmful effects to the living of organisms, which in practice normally means death, injury or adverse effects in humans when ingested, inhaled, or absorbed through the skin.
- **Environmental effects:** those which relates to the potential of a chemical to damage one or more environmental compartments (i.e. water, soil, air, and including the underground water recharge).

Routes of Entry into the Body

The process of entry into the body for a toxic or harmful agent is by absorption across the skin of the body, or across the lining (epithelium) of the lung or gastro intestinal tracts.

- **Inhalation:** entry is through the nose or mouth and along the respiratory passages to the lungs. The lung is the most vulnerable part of the body as it can readily absorb gases, fumes, soluble dusts, mist, and vapors. This is the main means of entry of biological agents. (NEBOSH HSE course manual 2009).

  Note that: there is a difference between *inhalable* substances and *respirable* substances. Inhalable substances are capable of entering the mouth, nose, and upper reaches of the respiratory tracts during breathing. Respirable substances are capable of deeper penetration to the lungs itself.

  It's the size of individual particles that determines whether a substance, dust, fumes, mist are inhalable or respirable. Gases and vapors will be respirable because of the tiny particle size, many fumes and mist will be respirable but again will depend upon how small they are.
- **Ingestion:** Entry is through the mouth and along the whole length of the gastro intestinal tract through the stomach and the intestines.

  Notes that; the contamination may occur as a result of swallowing the agent directly from eating/drinking in the contaminated environment.

  In some cases, quarry workers are mostly found taking meals in *Blasting* grounds, *Crushing plants*, *Cement* and *Asphalt plants (Marini)* in the Julius Berger Quarry site, and as such harmful substances can gain entry into the body through ingestion.
- **Absorption:** Entry is through the skin via the skin pores, eyes, either from direct contact with the agent or from contact with contaminated surfaces or clothing. Its mainly chemical liquid which enters the body in this way, although other forms of chemical may either sufficiently damage the skin to gain entry or find their ways through the eyes.

Health Surveillances and Assessment

Health and safety law places a duty on employers to ensure the health as well as the safety of their employees. Yet across industry, each year many more people become ill as a result of their work than are killed or injured in industrial accidents. Most diseases caused by work do not kill, but can involve years of pain, suffering and discomfort for those affected. It has long been recognized that health risks have not received the same attention as safety risks. Cole (1996) gives several reasons for this. These are:

- The health risk may not be understood or well defined and the cause/effect relationship not established.
- Health risks tend not to attract widespread publicity or demand the same urgent attention as safety risks.
- Health risks appear to have little, if any, short term effect and it may be that ill-health does not occur for many years after exposure.
- Health risks may be more difficult to address, resulting in attention being directed to risks where control is more visible and likely to attract tangible benefits
- Comprehensive data on the occupational ill-health may simply not exist in many cases and in practice; the true extent of occupationally related ill-health may be unknown.

Health problems may not be as obvious as a safety failure such as a structural collapse, machinery accident or a fire & explosion. Most people may never see cases of occupational ill health whilst at work. They may miss the connection between the effect and its causes, so it is even more important to adopt a proactive approach to managing health risks.

Typical Health Risks
Risks to health from work activities include:

- Skin contact with irritant substances, leading to dermatitis etc;
- Inhalation of respiratory sensitizers, triggering immune responses such as asthma.
- Badly designed workstations requiring awkward body postures or repetitive movements result in upper limb disorders, repetitive strain injury and other musculoskeletal conditions;
- Noise levels which are too high, causing deafness and conditions such as tinnitus;
- Too much vibration, e.g. from hand-held tools leading to hand arm vibration syndrome and circulatory problems;
- Exposure to ionizing and non-ionizing radiation including ultraviolet in the sun's rays causing burns, sickness and skin cancer.

There are a number of specific health and safety Regulations that deal with specific health hazards. These all require a risk based approach and include:

- Chemicals & hazardous substances: The Control of Substances Hazardous to Health Regulations, 1999.
- Noise: Noise at Work Regulations, 1989.
- Manual Handling: Manual Handling Operations Regulations, 1992
- Ionizing radiation: Ionizing Radiation (Protection) Regulations, 1985.

Control Measures
Although the most widely acceptable form of control measure is through the use of appropriate (PPE_s) personal protection equipment. $PPE_{(s)}$ are equipment which involves the use of systems designed to be worn by individuals to help reduce the possibility of harm from the hostile environment in which they are working.
The company; Julius Berger Nigeria PLC provides relevant PPE to its workers through the Department of Health Safety and Environment (HSE). The department issue out this PPE to the workers, but haven issued this PPEs it still have to make sure this PPEs are used by the workers and not sold out to the outside community in order to make profit.

Types of Respiratory Protective Equipment (RPE)
An important point to note about respiratory protection is that there are two basic but different types:

- Respirators, which are designed to purify respirable air by inhaling it through a filter which removes the contaminants.
- Breathing apparatus; which supplies pure air from an un-contaminated sources by means of a hose supplying uncontaminated air, compressed air from cylinders or a compressor, or as a self-contained unit carried by the user.

(a) Filter face-piece respirator
This type of respirator consists of a piece of filtering material worn over the nose, mouth, and secured by twin elastic headbands. Fits around the chin and face depends upon the tension in the headbands, a flexible metal strip enables the user to bend it over the nose bridge to affect a personal fit.

(b) Half mask respirators
Are respirators made with flexible rubber or plastic face-piece which covers the nose and mouth, to which a replaceable cartridge capable of removing the airborne contaminants during inhalation of respirable air. Some are single cartridge while others are double in nature.

(c) Full face or Canister respirator
Full face respirator as the name implies is designed to cover the mouth, nose, and eyes. They are made of flexible rubber or plastic face-piece which seals under the chin, around the cheek, and around the fore head, they have replaceable gas absorbent canister which are either fitted directly or connected via a flexible corrugated rubber breathing tube.

(d) Powered Visor respirator
This is a recent development of the powered clean air respirator. Purified air is blown down over the user's face behind a protective visor. The technique frees the user from a "sealed" unit, allowing a more comfortable fit and it's less restrictive to movement.
Other protective equipment and accessories includes: gloves, overalls, eye protections (spectacles, Goggles, face visors).
All PPE must be maintained in efficient working order by defined maintenances rules at a specified frequency, or where appropriate by a program of regular replacement. (RRC Business Training, NEBOSH INT'L Seminar 2001).

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