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EVALUATION OF BLAST GROUND VIBRATIONS AND DUST EFFECTS ON RESIDENTIAL AREA: A CASE OF WAZO HILL QUARRY

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ABSTRACT

Blasting activities in mining company has become one of the major factors affecting residential area around the mine. Despite all rules and regulation made to ensure safety of people living near by the mining areas, effect of blasting activities still exist to the people living nearby. Blasting is the process of breaking the rocks by using explosives. This process normally affects the residents who are staying around mining area. The study revealed that major effects found in the pit are vibrations and dusts and in most cases those effects are associated with operational and geological factors. The findings showed that, none of the residents have been suffered from serious diseases such as silicosis but depending on the distance from the mining area most of them suffered from minor diseases such as flu, cough and reduced visibility since the amount of dust have not exceeded the threshold limit of the limestone dust which is 10mg/m^3. Also findings revealed existence of ground vibration on residential area although the level of vibration appeared to differ from one place to another depending on the distance from the mining area. The closer the distance from the mining area the higher the effects appeared to be. In this study different methods have been suggested in order to reduce the blasting effects. The methods includes, reviewing the blast design and its parameters in relation to the rock mass and its nature, reallocation of residents away from the mining areas, application of hierarchy of hazard control methods.

KEYWORDS: *Ground vibration, Dust, Residential area, Blast, Quarry, Residents.*

1. INTRODUCTION

Wazo hill quarry is subcontracted by Tanzania Portland Cement Company limited **(TPCC)** to mine and supply raw materials for cement production. Tanzania Portland Cement Company Limited (TPCC) is a large company which is in the business of manufacturing, selling and distribution of high quality construction cement in Tanzania (Gastory, 2012).

Blasting is a process of initiating explosive charge to break rocks. Blasting is done after the charging process is completed and it is done by the process known as initiation. Blasting operation in any mine is done for the purpose of getting uniform sized material to suit subsequent operation like hauling, loading or crushing. In surface mining there are common parameters that affect the final or overall output after drilling and blasting has done. (Hartman H. 1990) In order for a blasting operation to be performed on the ground the pattern must be designed and applied. Blasting pattern is a way or mode at which the blast holes are to be laid on the ground. There are different types of blast patterns used in surface mines of which their selection depends on fragmentation requirements, geology of the area, explosives used and the type of drilling equipment used. These patterns are; Rectangular pattern, staggered pattern and square pattern. (Locke, C. E. 1990)

Explosives are chemical compound or mixture that can causes a sudden, almost instantaneous release of gas, heat, and pressure, accompanied by loud noise when subjected to a certain amount of shock, pressure, or temperature. (Hoppler, 1998)

Vibration is a wave motion that occur when a certain amount of explosive is detonated in a blast hole and then rapid motion of the charge takes place forming gases at very high temperature and pressure. The impact of blast vibration on residential area includes the cracks in their houses, fractures in their infrastructures, health effects like heart attack and damages on other construction activities. Ground vibration can be expressed in terms of Peak Particle Velocity (PPV) with units in mm/s. It should be noted that the PPV refers to the movement within the ground of molecular particles and not surface movement. The dislocation value in mm refers to the movement of particles at the surface movement. Vibration level that causes damage depends upon the peak particle velocity and the frequency at which it occurs. Damage is to be expected where peak particle velocity is high when its frequency is low. Monitoring of ground vibration is carried out using a vibrograph, also known as a seismograph. (A. Maslin, 2015)

Dust is the term used to describe the solid particles of microscopic size which produced by natural sources like volcanic activities, smokes, soils and sands and micro-flora and also industrial sources especially when the rock is broken by abrasion, crushing, impact, cutting, grinding or explosives. The solid particles are termed as aerosols when become contaminated with air. Dusts are classified according to their particle size and their physiological effects. In accordance with particle size dust can be classified as respirable dusts, coal and other dusts, normal atmospheric dust, diesel smokes, viruses, bacteria, tobacco smokes, pollens causing allergies, fog, mist and light drizzle while in accordance with physiological effects can be classified as toxic dust, carcinogenic dust, fibrogenic dust, explosive dust and nuisance dust. Huz-dust equipment can be used to measure or control concentration of dust on a given area.

2. METHODOLOGY

2.1. Site Description

Wazo hill quarry is located at Tegeta approximately 25km from the Dar-es-salaam city Centre. The quarry is located between latitude -6^{0} 34’ south and longitude 39^{0} 23’ and 39^{0} 25’ east which is nearly 100m above the sea level. The quarry is dealing with the mining activities such as drilling, blasting, loading and haulage of limestone materials from the pit up to the crusher.

2.2. Methods

2.2.1. Observation and consultations

Observation based on geological properties of the area, types of explosives used and drilling pattern used.

Wazo hill quarry is composed mainly of sedimentary rock. Sedimentary rock found in the area is formed by the decomposition of marine and other materials remains for many years forming sediments. Chemical composition of Wazo hill limestone is mainly $CaCO_3$ and SiO_2.Limestone is composed mainly of $CaCO_3$.Limestone consists chiefly of calcium carbonates shells and skeletons of these organism that inhabited oceans. Uncounted generations of these organisms lived and died to leave their shell and skeletal accumulated on sea floors such shells supplies are supplemented by chemically precipitated calcium carbonate. Throughout later geologic times, beds of other material were deposited over the carbonates and therefore caused pressures that gradually consolidated the carbonates into limestone. Individual limestone layers range from fraction of an inch to many feet in thickness massive strata of uniform texture indicate relative long period of uniform condition of sedimentation. A bedding plane commenced when these situation are momentarily altered normally each bedding plane marks the extinction of one deposit and launching of another.

In Wazo hill quarry the type of explosive that have been used is Ammonium nitrate (AN) mixed with fuel oil in a ratio of 94% AN and 6% fuel oil.

The drilling pattern that have been used in the mine (Wazo hill quarry) is staggered square pattern in which burden is equal to spacing.

2.2.2. Measurements and records

Measurement and record are based on vibration level per each blast and concentration of dust inhaled by individuals. Onavi sensor and Huz-dust equipments were used to record vibration level and concentration of dust respectively. Sample frame considered to be evaluated were Wazo hill primary school which is 1248m from blast block, dispensary which is 1507m from blast block and Chasimba village which is 680m from blast block.

3. ANALYSIS

3.1. Evaluation of dust concentration

Number of sample and concentration of dust

Number of sample	Concentration of dust (mg/m^3)	Number of sample	Concentration of dust (mg/m^3)
C1	0.034	D4	0.011
C2	0.056	D5	0.019
C3	0.031	D6	0.017
C4	0.046	P1	0.020
C5	0.044	P2	0.034
C6	0.037	P3	0.032
D1	0.012	P4	0.021
D2	0.021	P5	0.026
D3	0.017	P6	0.024

Table 1: Shows concentration of dust per each blast

From the table 1 above, starting from C1 to C6 are the numbers of samples taken around Chasimba village, D1 to D6 are the numbers of samples taken near the dispensary area and from P1 to P6 are those samples taken nearby Wazohill primary school.

The following graph shows concentration of dust on the sample of residential area

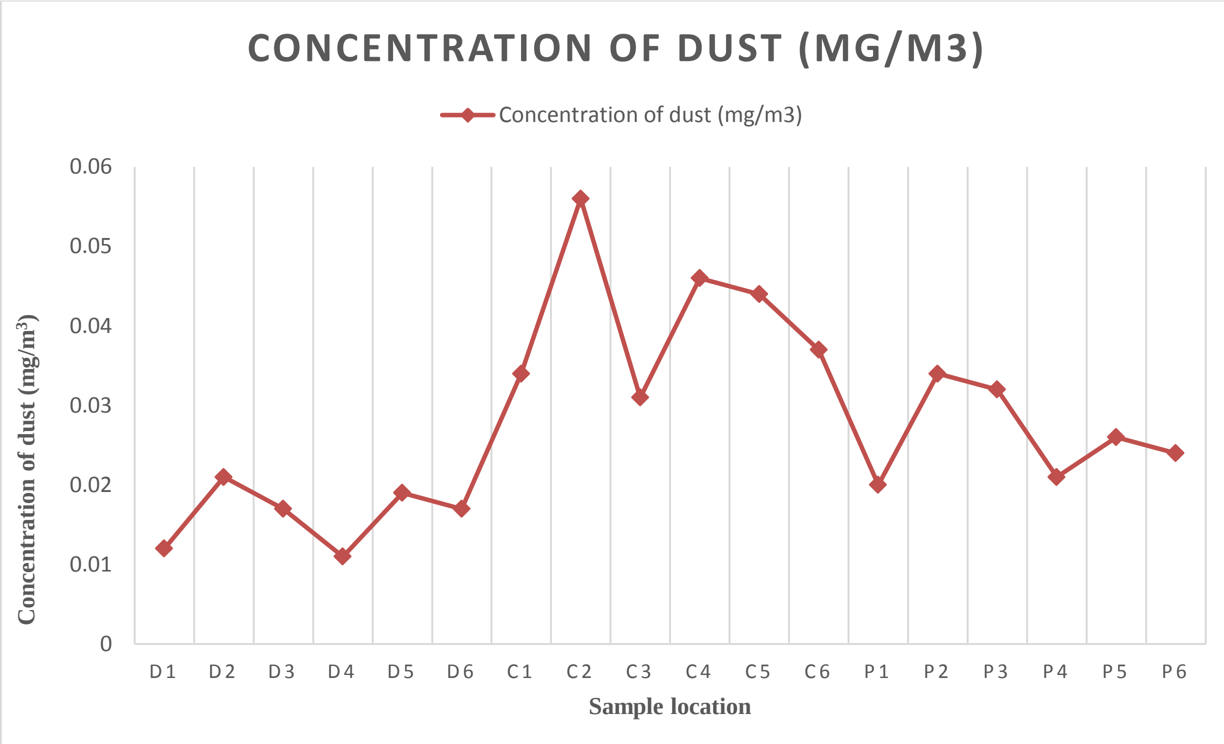

Figure 1: Shows the concentration of dust.

3.2. Evaluation of vibration level

Vibration level records

Blast block	Residential	Distances(m) from blast block	Blast 1 vibration level (mm/s)	Blast 2 vibration level (mm/s)
A	Primary school	1248	7.1	5.3
B	Dispensary	1507	6.0	4.2
C	Chasimba	680	9.2	7.1

Table 2: Shows vibration level

The following graph shows vibration level on the sample of residential area

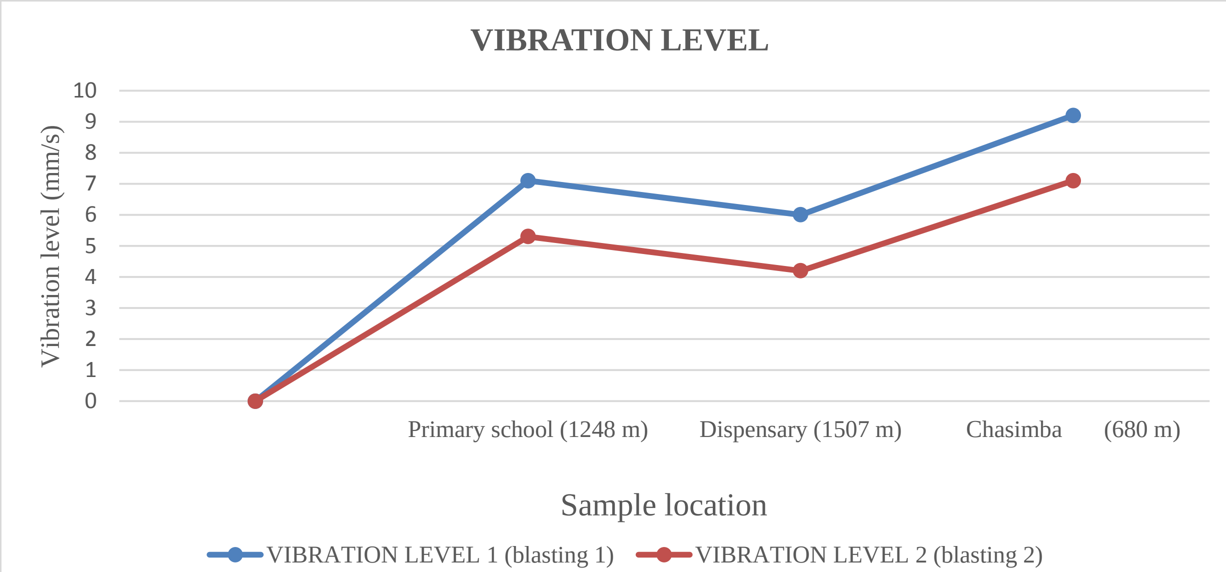

Figure 2: Shows vibration level

4. RESULTS

Analysis proved that there is concentration of dust on residential area nearby the quarry, the amount of concentration differ from one residential area to another depending on the distance from the blast block. Based on the sample frame of this study, concentration of dust appeared to be higher at Chasimba village and less at Dispensary. Since the amount of dust has not exceeded the threshold limit of the limestone dust which is 10mg/m^3, hence most of residents suffered from minor diseases such as flu, cough and reduced visibility. None of the resident seems to suffer from silicosis.

Blast one vibration seems to have the higher level compared to the blast two. The higher level of vibration is caused by uncontrollable parameters which are based on geological structures such as geology of rocks, rock characteristics and the uncontrollable parameters which are mainly related to the blast design and the type of explosive used also its amount. Upon comparing sample residential area on the case of vibration, Chasimba village receive more effect compared to the other residential area, this is due to the fact that it is closer to the blast block. According to building classification on effect of vibration level, the intermittent vibration limit for residential with general good repair is 10(mm/s) while for the residential where preliminary survey reveals significant defects the limit is 5(mm/s) also vibration level for stable structures should not exceed average of 7.5mm/s while 3.8mm/s for unstable structure . Nevertheless the effect is not severe in both samples residential, large numbers of residents who stay at Chasimba have experiencing the effect of vibration more than other residents from Primary school and Dispensary.

5. CONCLUSION

The rock blasting resulted to a number of effects on the environment. The findings reveals that the amount and type of explosive used have direct influence on the effects associated with blasting activities. Too much explosive resulted into vibration and concentration of dust and thus affects the residents located near the mine. The company has somehow monitored the dust thus the average concentration of dust doesn't exceed the threshold limit value (10mg/m^3), they only have minor impacts to the surrounding community which attacks the eyes, nose and throat and results into flue, cough and reduced visibility.

The vibration level in Chasimba is too high with average of 8.15mm/s which have great effect to the people of Chasimba and it was caused by the parameters that are mainly related to the blast design, the type of explosive and the parameters that are based on geological structures such as geology of rocks and rock characteristics.

Since the residents should be located at least 1km far away from the mining areas, therefore Chasimba residents should be relocated in order overcome effects related to mining operations such as blasting activities' effects. Frequency review of the blasting design and its parameters in relation to the rock mass and its nature so as to adjust some factors like hole depth, stemming height, charge mass, the type of explosive and type of stemming material used that can contribute to the effects of blasting.

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