Measurement of Ground Vibration Generated in Limestone Blasting in Edo State Using Rectangular Drilled Pattern

[1]Taiwo M. Edo, [2]Christopher Aigbogun, [1]Aigbe Ogunbor.

[1]Department of Petroleum and mineral resources, Edo State Polytechnic (taiwoedo@yahoo.com)

[2]Department of Physics (Geophysics Option), University of Benin (caigbogun@uniben.edu)

ABSTRACT

Ground vibrations is a part of the output of the blasting operations. When its level is high, it causes human annoyance, discomfort, and damage to nearby structures. Measurement of ground vibrations and use of published damage criteria are necessary to judge the design of the blasting operations if it complies with the safe regulated levels. This investigation was carried out to determine the magnitude of vibration generated from quarry in Edo State when blasting in rectangular multi-hole drilled pattern. Measurement and recording of peak particle velocity of blasting from limestone quarry using modern tri-axial accelerometer was employed in the investigation. Different charge weight of explosives at various distances were carried and the data obtained were analysed using scaled distance and propagation laws for ground vibration in addition to comparison to some predictors equation to predict conservative safe distance between structures and blast point.

INTRODUCTION

Blasting is the principal method of rock breakage in mining and construction projects throughout the world. This is due to its distinct advantages like economy, efficiency, convenience and ability to break the hardest of rocks. However, only a portion of the total energy of the explosives used in blasting is consumed in breaking rocks while the rest is dissipated as vibration, in the form of seismic waves traveling very rapidly within the ground and along the ground surface and as airblast (air overpressure), in the form of compression waves traveling through the air. With increasing mining and construction activities in areas close to human settlements, ground vibration has become a critical environmental issue as it can cause human annoyance and structural damage Abdel-Rasoul, (2000). The magnitude of vibration generated from blasting in quarry depend amongst other factors on volume of explosive loaded in a hole, distance from the blast point to the point of interest and the pattern of holes drilled. In rectangular drilled pattern the spacing and burden differs.

SITE DESCRIPTION

Rectangular drill pattern with spacing of 2.0 meter and burden of 1.5 meter (spacing > burden) was employed. The site was cleared of trees and overburden. Eleven blasting were monitored and recorded. 500 ms delay initiation time was the delay initiation time. Table 1 shows the measured and recorded values of distance, weight of explosives, scaled distance and peak particle velocity. Figures 1 to 3 shows the graphical representation of the data.

TABLE 1

DISTANCE (m)	WEIGHT (Kg)	SCALED DISTANCE		PPV (m/sec)
		SQUARE ROOT ($m/kg^{0.5}$)	CUBE ROOT ($m/kg^{1/3}$)	
115.0	100	11.500	24.776	70.5
175.1	150	14.297	32.955	50.6
190.5	150	15.554	35.854	44.0
376.0	200	26.587	64.295	19.3
440.0	200	31.113	75.239	15.0
480.0	180	35.777	85.013	21.0
360.0	200	25.456	61.559	20.5
380.0	180	28.324	67.302	17.4
250.0	150	20.412	47.052	29.0
150.0	150	12.247	28.231	64.0
280.0	200	19.799	47.879	30.4

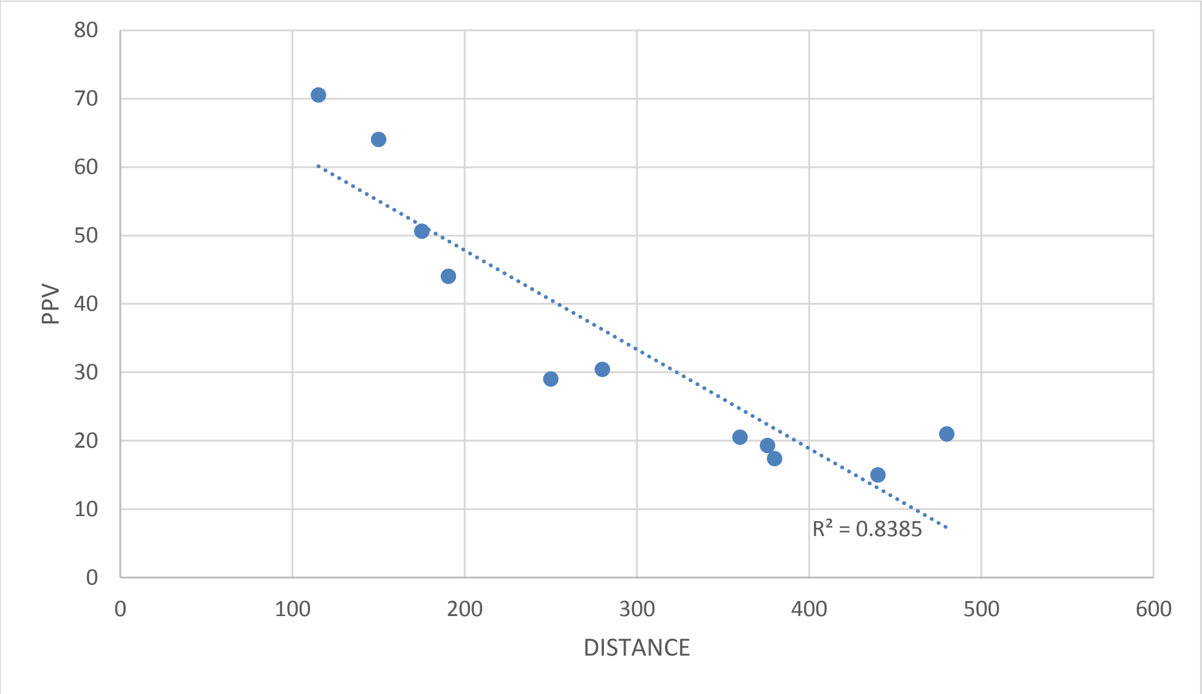

Fig. 1: PPV versus distance

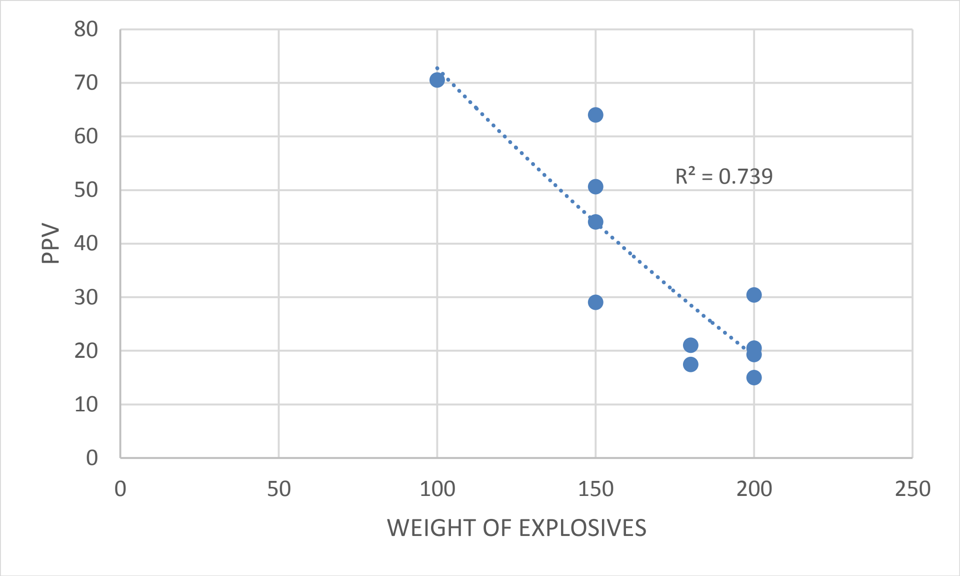

Fig. 2: PPV versus weight of explosives

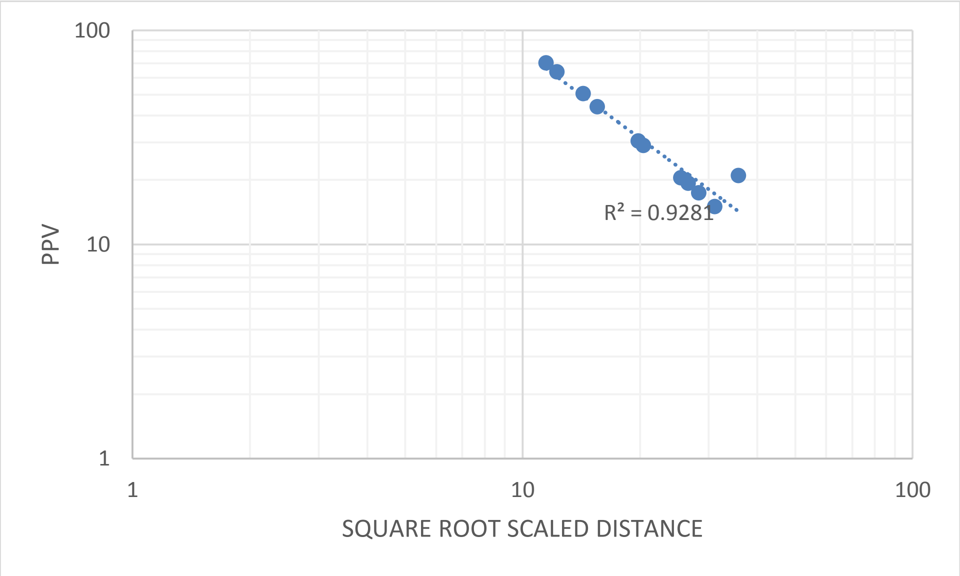

Fig. 3: PPV versus weight of explosives

Table 2: Summary of result of Regression analysis of some predictors equation

	USBM	AMBRASEYS-HENDRON	LANGEFORS & KIHLSTROM	INDIAN STANDARD	GHOSH-DAEMON
R^2	0.9281	0.9374	0.9001	0.6330	0.8520

DISCUSSION OF RESULTS

On this limestone site, the Ambraseys-Hendron predictors equation which has the highest correlation (R^2 = 0.9374) was used as a conservative guide for predicting the safety of structures in the area.

The maximum peak particle velocity recorded is 70.5 mm/s with the weight of explosive of 100 kg at a distance of 115 m. The cube root scaled distance is 24.776 m/kg$^{1/3}$ and the square root scaled distance is 11.500 mm/kg$^{0.5}$. The minimum peak particle velocity recorded is 15.0 mm/s at a distance of 440 m with explosive weight of 200 kg. The average weight of explosive used in the site was 169.1 kg.

Using the widely accepted limit for residences near construction blasting and quarry blasting. (Bu Min Bulletin 656, RI 8507, various codes, specifications and regulations) and also using the regression analysis with an average weight of explosive of 169 kg, the safe scaled distance from the blast point to the nearest residential building should be at least 75.239 $m/kg^{1/3}$. That is for an explosive weight of 169.1 kg, the actual distance from the blast point to the nearest residential building for a conservative PPV of 50 mm/sec, should not be less than 277 m.

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