# Comparison between the propagation plots from PPV and PVS records

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## 1. INTRODUCTION

Prediction equation is usually estimated from the PPV(Peak Particle Velocity). But people tend to use PVS(Peak Vector Sum) in Korea. In this study, authors analyzed and compared the prediction equations from PPV and PVS, which were chosen from the test blasting data used to determine the standard prediction equation of "The guide of rock blasting design of Korea Ministry of Construction and Transportation (MOCT, 2006, MOCT is now renamed as the Ministry of Land, Transport and Maritime Affairs)".

## 2. TYPE AND PROPERTY OF BLASTING VIBRATION VELOCITY

Through research about surface structures damage, Duvall and Fogelson(1962, requited from Siskind, 2000) found that vibration velocity was main factor in structure damage. And the vibration velocity was used as damage assessment factor in a report of investigation of United Stated Bureau of Mine (USBM RI 5968). Siskind etc.(1980, requited from Siskind, 2000) developed the idea a little further. They complemented an assessment standard of vibration velocity at USBM RI 8507. This report was accepted by the United Stated Office of Surface Mining that has affected assessment standards of vibration velocity of many countries. PPV and PVS are internationally used properties of particle velocity (Siskind, 2000).

### 2.1 PPV

In Siskind's phrase, "peak particle velocity (PPV), or peak ground vibration, is defined as the highest particle velocity of any of the three components of motion without respect to plus or minus sign", as can be seen in the following quotation: horizontal component (L), horizontal component orthogonal progress way (T), vertical component (V). Maximum value in three components is used to estimate the prediction equation.

### 2.2 PVS

The term of definition of vector sum is slightly different depends on researchers. In this study, authors divide the vector sum into peak pseudo vector sum and peak true vector sum.

The peak pseudo vector sum is vector sum of three maximum components, namely PPV (L, T, V). The equation is presented in Eq. (1).

$$PVS_{PSEUDO} = \sqrt{L^2 + T^2 + V^2} \quad (1)$$

The peak true vector sum is maximum value of real-time vector sum of three component (x(t), y(t), z(t)) that was sampled by interval time. 'n' is sampling frequency in Eq. (2).

$$PVS_{TRUE} = \sqrt{x(t_i)^2 + y(t_i)^2 + z(t_i)^2} \quad (2)$$

$$(i = 1,2, \ldots, n)$$

Usually, PVS (peak vector sum) means peak true vector sum.

Recently, widely-used commercial vibration monitors measure ground vibration velocity and display both of PPV and PVS. Displayed PPV means L, T, V and PVS means $PVS_{TRUE}$.

### 2.3 The issue of application of PPV and PVS

In Korea, assessment standard of vibration velocity was established from standards of other countries. Although the level of vibration velocity was clear, the definition of vibration velocity was not clearly defined. Engineers designed from the prediction equations estimated from the PPV data but officers or auditors assume the vibration level as PVS values. To meet the misunderstanding, some engineer began to use the PVS data for their prediction equations.

In this study, to show the differences of PPV and PVS, authors analyzed and compared the prediction equation from PPV and PVS data obtained from the same records.

## 3. ACQUISITION AND ANALYSIS

### 3.1 Data acquisition

Used records in this study are blasting vibration data which was used to determine the standard prediction equation of the rock blasting design guide of MOCT (Yang et al., 2006, 2007). This data was measured for 3 years from the various sites in Korea.

The records are selected from the acceptable data where the blasting was carried out by standard surface blasting methods. They showed clear and distinctive value of PPV and PVS. 72 cases from the 120 blasting reports were chosen and acceptable data set was 1948.

The types of base rocks were spread from igneous, metamorphic rocks to sedimentary rocks. Most frequent rock types were granite and gneiss.

### 3.2 The analysis of Prediction equation

The prediction equations were estimated by regression (Fig. 1, Fig. 2). Square root scaled distance was used as was applied to MOCT guide.

Determined prediction equations are $V_{95}(\mathrm{PPV}) = 352.3(\mathrm{D}/\sqrt{\mathrm{W}})^{-1.63}$ and $V_{95}(\mathrm{PVS}) = 400.2(\mathrm{D}/\sqrt{\mathrm{W}})^{-1.62}$. Table 1 indicates detail of analysis result.

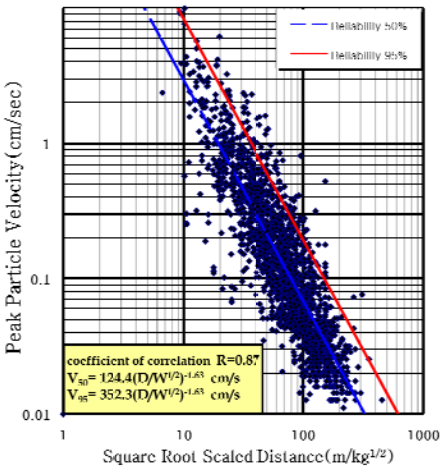


Fig. 1 Prediction equation from PPV

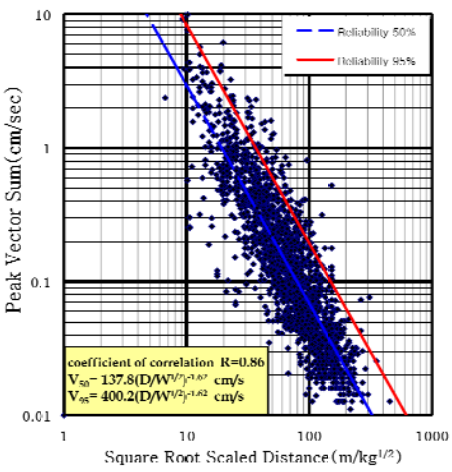


Fig. 2 Prediction equation from PVS

Table 1 Detail of prediction equation

| | $K_{50}$ | $K_{95}$ | n | r | Measurement number |
|---|---|---|---|---|---|
| PPV | 124.4 | 352.3 | -1.63 | 0.87 | 1948 |
| PVS | 137.8 | 400.2 | -1.62 | 0.86 | 1948 |

## 3.3 Relation of distance and weight per delay

Fig. 3 is the relationship between distance and weight per delay. In this graph, vibration velocity is 0.3m/s constant. At the same distance, PVS weights per delay are less than PPV ones. It means using the PVS equations, design can be more conservative. It is like using some extra safety factor.

At 100m distance, weight per delay difference of PPV and PVS is 0.33 kg and at 200m, it becomes 1.30kg. It means that difference in weight per delay is varying by distance and the extra safety factor cannot be a constant.

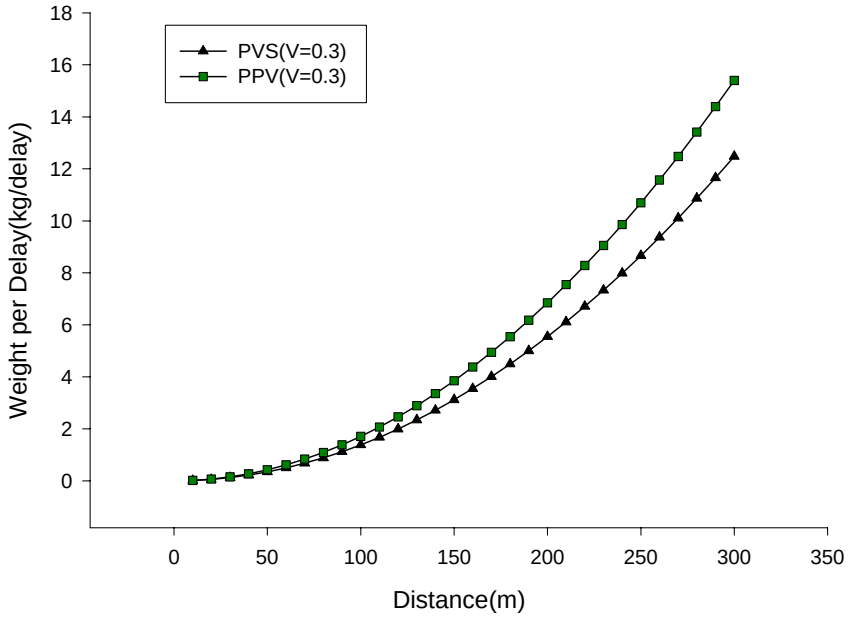


Fig. 3 Relationship between distance and weight per delay (V=0.3m/s)

Fig. 4 is the relationship between distance and weight per delay with different vibration limit level. In this graph, vibration velocity is 0.3m/s and 0.5m/s. Weight per delay difference of PPV and PVS increases from 1.30 kg to 2.40 while the vibration limit increases from V=0.3m/s to 0.5m/s at 200m. It shows that as velocity limit increases, the difference increases.

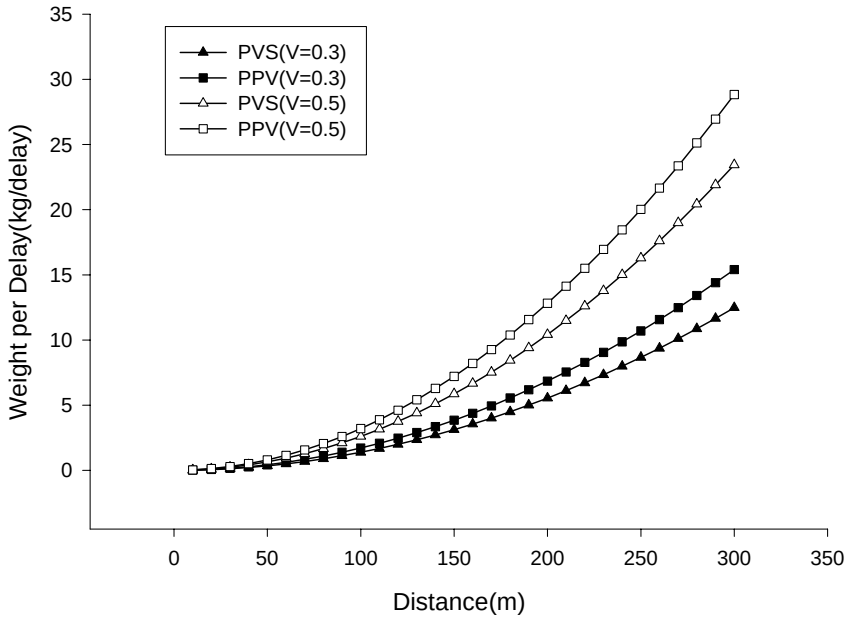


Fig. 4 Relation of distance and weight per delay (V=0.3m/s, V=0.5m/s)

## 4. CONCLUSION

In this study, records used for MOCT guide was reanalyzed to show the difference in prediction equations reduced from PPV and PVS values. Obtained results show that prediction equation by PVS data can be used to design conservative way, but the safety factor applying by this equation is not constant. The difference in weight per delay for PVS and PPV estimation is varying as distance and velocity limit varies.

## REFERENCE

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