On the Area Coverage of Grit Blasting

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1. INTRODUCTION

Full coverage, i.e. completely covered with dent, is a base of grit blasting. Now a days, area coverage is usually calculated by next formula, \( C = 1 - (1 - C_1)^m \) \[1\]. Although this formula means that full coverage didn’t reach, but we know that full coverage is easily reached on ordinary process.

The purpose of this paper is to obtain the relation between blasting conditions and area coverage including full coverage. Grit blasting was performed for plain carbon steel (0.45%C) under several conditions. Measured factors are area coverage and full coverage.

2. FORMER THEORY

Now, area coverage may be calculated with the next equation by SAE,

\[
C_s = 1 - (1 - C_1)^m \tag{1}
\]

![Fig. 1. Influence of blasting time on area coverage. (SAE)](image)

This equation does not lead full coverage till infinite time as shown in Fig. 1, and not found to be suitable for calculating area coverage and full coverage. For this 98% coverage is used conventionally as full coverage. Namely, this equation contains basic contradictions in practice.

3. EXPERIMENTAL PROCEDURE

Blasting conditions, equipment, grit and work material are shown in Table 1. Treatments of data on dent and coverage are as follows;

i. Diameter of dent was determined from mean values calculating from long and short diameters of 20 dents.
ii. Area coverage was determined from the ratio of total area of dent on blasted surface from photo enlarged six times.

4. RESULTS

4.1 Area Coverage

The relations between area coverage and blasting time are shown in Fig. 2 (page 18), and the increasing ratio of area coverage is divided into the 1st and 2nd term. There are very few overlapped dents in the 1st term, and most of all dent are overlapped partially in the 2nd term.

Factors which affect area coverage are area of one dent and number of dent. The former is determined by mean diameter of dent (d), and the latter is determined by the density of dent on unit area of specimen.

As shown in Fig. 3 (page 18), the relation between the mean diameter of dent and grit size and velocity can be linear on the logarithmic coordinate, and the formula is;

\[
d = k_D . D . V^{1/2} \tag{2}\]

Therefore, mean diameter is in proportion to grit size and square root of grit velocity.

With same procedure, density of dent has been found to be in proportion to the sectional area of lead pipe and in inverse proportion to the cube of grit size as shown in Fig. 4 (page 18).

Therefore, the formula on the number of dent per unit time and unit area of specimen N is as follows,

\[
N = k_D . D . d . V^{1/2} \tag{3}\]

Total area of dent per unit time and unit area of specimen Q is the product area of one dent (Si) and N in eq. (3). Therefore, the next equation as obtained,

\[
Q = S_i . N , \text{ where } S_i = \pi \cdot d_i^2 / 4 , \hspace{2cm} = k_D . D . d . V^{1/2} \tag{4}\]

Because initial area coverage C1 is defined by (A.Q)/A, where A is blasting area, and C1 is equal to Q. Namely, Q is the maximum value of area coverage per unit time.

The relation between initial area coverage and grit size and velocity are shown in Fig. 5 (page 18) on logarithmic coordinate, and from this results, the equation (4) is confirmed.

As shown in Fig. 2, the relation between area coverage (C) and total dent area per unit time (Q), blasting time (T) can be expressed in the following equation.

\[
C = k_C . Q . T^n \tag{5}\]

Here, coefficient \( k_C \) means the overlapping ratio of dent and exponent \( m \) means the blasting efficiency. Fig. 6 (page 18) shows the relation between initial area coverage and \( k_C \), m in 1st and 2nd terms. Exponent m is 0.6 - 1.0 in the 1st term, and 0.06 - 0.11 in the 2nd term.

4.2 Full-Coverage Time

The influences of diameter of the lead pipe, grit size and velocity on full coverage time are shown in Fig. 7 (page 18). From these, the relation is as follows;

\[
T_f = k_T . D . D . V^{1/2} . V^{1/2} \tag{6}\]
The influence of the hardness of work material on full coverage time is shown in Fig. 8, full coverage time is in proportion to the square root of the hardness.

5. CONCLUSIONS
The increasing ratio of area coverage is clearly separated into two terms (the 1st and the 2nd) at 85% coverage.

Area coverage is affected by factors such as the number of dent per unit time on unit work area, and total dent area per unit time. Area coverage can be expressed the next formula:

\[ C = k_c \cdot Q \cdot T^m \]

Here \( C \) : area coverage, \( k_c \) : material constant, \( Q \) : total dent area, \( T \) : blasting time, \( m \) : exponent (0.6 - 1.0 in the 1st, 0.06 - 0.11 in the 2nd)

Full coverage will be reached in a few minutes, and the relations among full coverage time \( T_f \) and diameter of lead pipe \( D_l \), grit size \( D_g \), grit velocity \( v \) are shown as the next equation.

\[ T_f = k_r \cdot D_l^{0.5} \cdot D_g^{0.2} \cdot v^{1} \]

where \( k_r \) : work material constant involved hardness

6. REFERENCE