

ANALYZE OF CONTACT PRESSURES FOR BRAKING SYSTEM FOR HOISTING MACHINE

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***Abstract:** The paper present parts of researches in the range of braking systems for hoisting machines, especially the studies of acting forces and contact pressures located to the one piece rim and brake shoe.*

***Keyword:** Rim, brake shoe, contact pressure.*

1. INTRODUCTION

The braking system is an important part of machines with influences to the performances of machines. The failure of braking systems can conduct to serious material damages or to human casualties.[1]

The most researches, theoretical or experimental, analyze the braking systems with small dimensions (for cars, trains, locomotive, railway engine, etc.)[3]. This study is applied to the braking system of hoisting machine.

The hoisting machine is the mining equipment designed to transport the personal and materials from surface to underground and from underground to surface. The distances of transport and the load-carrying capacity lead to braking systems with big dimensions. For example the rim of braking system for hoisting machines can be bigger than 3500 mm.(fig. 1), and is important to analyze the acting forces and the contact pressures.

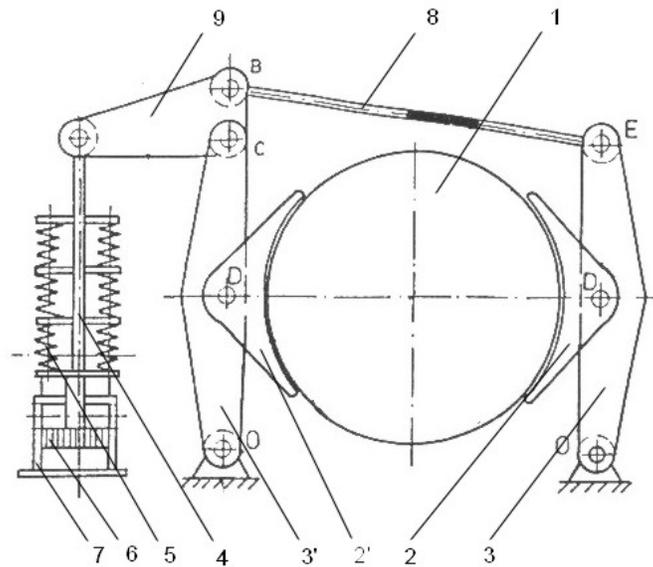


Fig. 1 Braking system for hoisting machine (functional diagram) [5]

2. DISTRIBUTIONS OF CONTACT PRESSURES ON CONTACT-BRIDGE PIECE OF BRAKE SHOE WITH RIM

For determination of calculus relations was made some basis of design:

- the specific pressure is the same on the width of contact between the rim and the brake shoe [2];
- the variation of specific pressure is just on the length of contact between the rim and the brake shoe;
- the simplify diagram of braking system is presented in figure 2 and the contact pressure distribution is presented in figure 3.

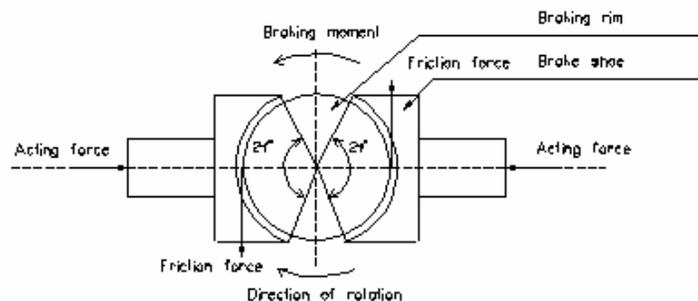


Fig. 2. The simplify diagram of braking system

The acting forces on rim (fig. 2) are:

- the normal force, N ;
- the friction force, F .

$$F = \mu \cdot N \quad (1)$$

where μ is friction coefficient.

In this case the total contact pressure can be estimated with the relation:

$$P = P_N + P_f \quad (2)$$

where:

- p_N is the contact pressure created by the actuation mechanism of brake;
- p_f - contact pressure produced by friction forces between brake shoe and rim.

$$p_N = \frac{N}{S} \quad (3)$$

- S – contact surface between brake shoe and rim.

$$S = b \cdot l \quad (4)$$

- b – width of brake shoe;
- l – length of brake shoe.

$$p_f = \frac{F}{S} \quad (5)$$

The size of elementary friction forces is in direct correlation with distribution of acting forces developed by the actuation device.

For the brake system for the hoisting machine type 2T 3,5 X 1, 7A (fig. 1) the normal acting force is [4][5]:

$$N = \frac{G_0 \cdot d \cdot z \cdot f_a \cdot i}{8 \cdot c^3 \cdot k_1 \cdot n} \quad (6)$$

where:

- G_0 - coefficient of elasticity for the spring material;
- d - diameter of whirl of spring, [cm];
- z – number of spring in pack;

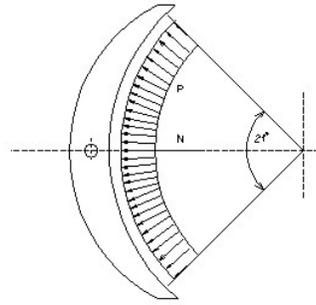


Fig. 3 The contact pressure distribution [2]

- f – deformation of spring in brake position [cm];
- c – compression ratio between the mean diameter of springs D_m and diameter d for round steel:

$$c = \frac{D_m}{d} \quad (7)$$

- n – number of working whirl of springs;
- k_1 – coefficient;

$$k_1 = 1 + \frac{1}{2c} - \frac{1}{2c^2} \quad (8)$$

- i – compression ratio of lever system.

By replacement of (6) in (1) result:

$$F = \mu \cdot \frac{G_0 \cdot d \cdot z \cdot f_a \cdot i}{8 \cdot c^3 \cdot k_1 \cdot n} \quad (9)$$

From (3), (4), (5) and (9) result:

$$p_f = \frac{F}{b \cdot l} \quad (10)$$

$$p_N = \frac{N}{b \cdot l} \quad (11)$$

$$p_N = \frac{\frac{G_0 \cdot d \cdot z \cdot f \cdot i}{8 \cdot c^3 \cdot k_1 \cdot n}}{b \cdot l} \quad (12)$$

$$p_f = \frac{\mu \frac{G_0 \cdot d \cdot z \cdot f}{8 \cdot c^3 \cdot k_1 \cdot n}}{b \cdot l} \quad (13)$$

$$p = p_N + p_f \quad (14)$$

$$p = \frac{\frac{G_0 \cdot d \cdot z \cdot f_a \cdot i}{8 \cdot c^3 \cdot k_1 \cdot n}}{b \cdot l} (1 + \mu) \quad (15)$$

The equation 15 is the start point for analyze of contact pressure of brake shoe on rim. Using MathCAD was build the graphics for variation of contact pressure function by:

- dimensions of brake shoe (figure 4);

- coefficient of elasticity for the spring material (figure 5);
- deformation of spring (figure 6);
- friction coefficient (figure 7).

Fig. 4 Variation of contact pressure function by dimensions of brake shoe

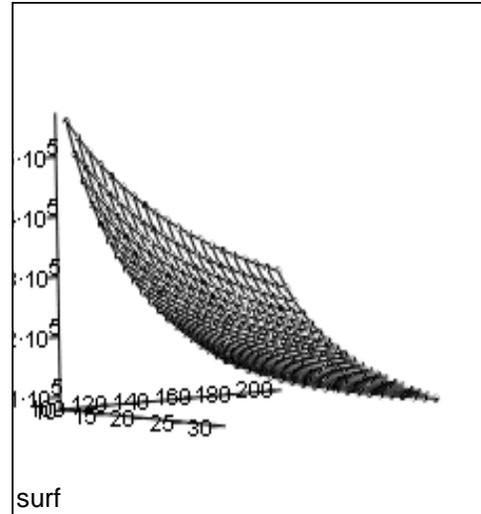


Fig. 5 Variation of contact pressure function by coefficient of elasticity for the spring material

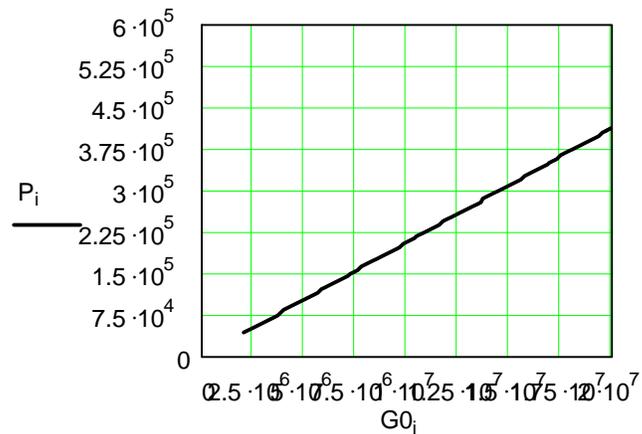


Fig. 6 Variation of contact pressure function by deformation of spring

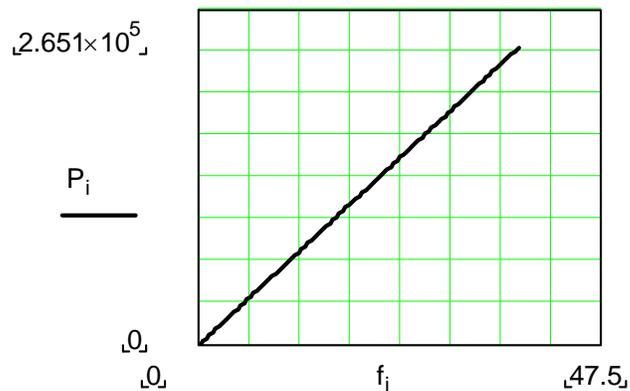
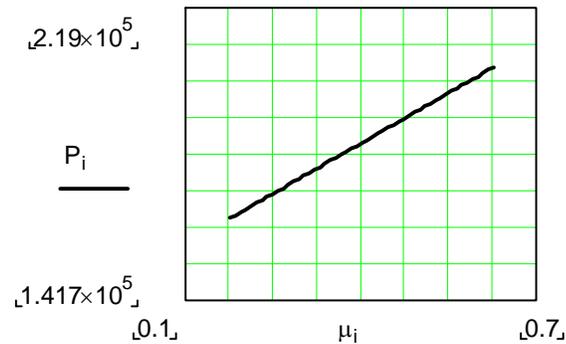


Fig. 6 Variation of contact pressure function by friction coefficient



3. CONCLUSIONS AND EXPECTATIONS

Analyzing the graphics was made some conclusions:

1. The contact pressure is decreasing with the increasing of the dimension of brake shoe. The graphic permit to dimension the surface of brake shoe in accord with maximum contact pressure on rim and with the maximum acting force.
2. The contact pressure is in direct concordance with coefficient of elasticity for the spring material, deformation of spring and friction coefficient. The conversion conductance is specific for each factor.
3. The calculated value of contact pressure permit to go forward to calculus of compression strain of rim ring.

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