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LIFTING MACHINERY THE EFFICIENCY CRITERION

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ABSTRACT

Using lifting and carrying machinery in various environments leads to a considerable variation of operating time and mechanical devices or metallic structure state of load. Lifting equipment is a cyclic operating device alternating between work and break time. The continuous increase of work amount determines the volume and characteristics of the lifting machines and installations.

1. Introduction

The comparison between technical and functional parameters of the cranes and the assembling characteristics of the prefabricated elements leads to the proper crane selection. It often happens to result several options. One cycle time (t), lifting height (h), action range (R), and lifting speed (v) determine the efficiency of a lifting machine, which expresses the operating capacity of the equipment to perform a certain amount of work in a definite time according to a defined technology.

The operating time $-(t_z)$ can be determined according to the average number of daily cycles (N_z) and specific operating time during one cycle (t_f):

$$t_z = t_f \cdot N_z \text{ [h]} \qquad (1)$$

Operating cycle of a certain mechanism consists of starting time, operating time at nominal speed, braking time and break time until the next starting.

Specific operating time (t_f) can be approximately determined, considering the operating speed and space, because of irrelevant braking and break time compared to the nominal speed operating time. The total specific operating time can be determined, considering the daily average operating time:

$$T = t_z \cdot z_1 \cdot a_s \qquad (2)$$

z_1 – the annual operational days as

a_s - the total operational time of the mechanical device (years).

The calculation and the technical expertise of the most challenged mechanical parts can be done, considering the daily average and the total specific operating time.

The lifting height is the maximum distance between the lowest and the highest position of the main lifting or grabbing device’s median line. The lifting height is marked **as** ’’**h**’’ (meters**)** when the load is pushed up. The lifting height is shorter in case of specific grabbing device attaching .The added device’s height has to be considered. The lifting height is measured from the lower point grabbing device could reach. This point could be located below the main level. This particular case is also considered.

Operating range is the distance R (meters) from the axial line of the main revolving part to the axial line of the grabbing device. Operating range of a no revolving crane is the distance from the axial line of the grabbing device to the axial line of the joint between the main structure and the arm of the crane. The operating range could be either specific or variable. Maximum range R_{max} and minimum range R_{min} are the margins of the variable operating range. R_{max} is the specific operating range in this case. Lifting height could determine the variation of the operating range because of the bascule arm action. H_{min} is the lowest maximum lifting height and H_{max} is the highest in this case. The variation of the operating range because of the variation of the lifting height is calculated below curb

$H = H(R)$; $R \in [R_{min}, R_{max}]$ belongs to the load parameter field.

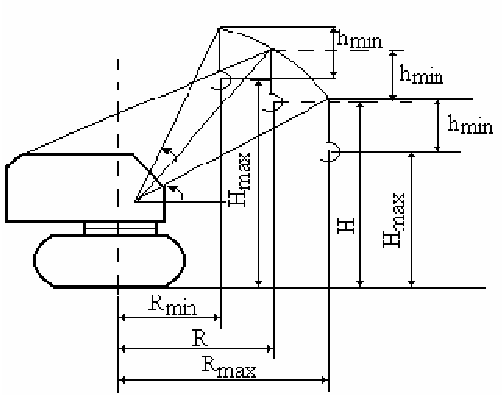

Figure 1

Total weight Q (tons) is the total load supposed to be lifted during the exploitation of the crane. It consists of G (the weight of the load), q (the weight of the hook, girder and other fitting devices).

$$Q_n = G + q \quad (3)$$

Accepted weight in a certain position of the arm can be defined considering its action range and bending angle. This is the particular case of crane's arm variable opening.

Operational speeds are certain values of the crane's movement.

Vertical movements are translation movements measured in m/min. The speeds of the revolving movements of the rotating parts are measured in rot/min. The movements of the bascules are measured as shown below:

t_b (s)- the time of the bascule's motion and

$$v_b = (R_{\max} - R_{\min}) / t_b \quad (m/\min) \quad (4)$$

2. Efficiency - classification

There are 3 efficiency categories: theoretical efficiency, technical efficiency and operating efficiency.

a) Theoretical efficiency – the amount of production achieved by the machine during one hour of continuous activity

The value of the theoretical efficiency is unique for the lifting equipment:

$$P = n \times q \quad [cant / h] \quad (5)$$

q – theoretical production amount
n = 3600/tc number of cycles in one hour
tc = theoretical time of the working cycle of the equipment [sec]

b) Technical efficiency – the amount of production achieved by the machine in one operating hour. Technical efficiency is defined as shown below:

$$P_t = P \times k_c \quad (6)$$

P – theoretical efficiency
kc – real operating values rate

c) Operating efficiency – defined by de following mathematical formula

$$P_e = \frac{60}{t} \cdot Q_n \cdot k_q \cdot k_t \quad \text{(t/k)} \quad (7)$$

P_e – operating productivity (t/h)
Q_n – total weight (t)
t – the time of one cycle
k_q – intensive operating rate
k_t – extensive operating rate
k_q and k_T are unknown elements.

a) Their values can be determined as it follows:

$$k_q = \frac{k_{r1} \cdot g_1 + k_{r2} \cdot g_2 + ... + k_{rn} \cdot g_n}{g_1 + g_2 + ... + g_n} \quad (8)$$

$k_{ri} = \frac{g_i}{Q_n}$ - the operating rate for each weight part g_i;

Q_n - the lifting capacity of the crane for minimum range

b) k_T can be calculated considering operational breaks according to the crane surveillance schedule

3.Conclusion

The efficiency, as an outstanding performance, stands for the capacity of the crane to operate in real life conditions in order to perform a certain amount of work in a period, according to an implemented technology.

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