STUDY OF IMPACT OF POSITIONING THE OBJECT SURVEY AND SELECTION OF WORK POSITION ON THE BURDEN OF WORK

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Abstract: The report describes the importance of the right choice of working position and positioning of the object to the operator when performing machining and assembling operations.

The influence of the system of external forces, arising from manual handling of power tools, burden of the work. Their counterproductive force has an applied point on the human palm.

From there, the power is transmitted and affect each of the elements (hand, body, foot, base) of the power chain - the system of muscles, bones, and joints of the human.

Keywords: positioning, work position, burden of the work.

1. INTRODUCTION

When performing the plumbing-assembling technological processes, used in the maintenance and repair of energy machines and equipment, hand-held power tools are often used to facilitate the rapid and qualitative execution of assignments..

According to the normative documents, the necessary conditions for ensuring the safety and health of the workers, in particular their long-term working time and protection from fatigue must be created in the organization of the work activity. Therefore, optimal working and rest periods for workers should be introduced in enterprises, according to the specifics of their work, as well as the characteristics and elements of their workplace.

The purpose of this study is to analyze the influence of the system of external forces, arising in the manual operation of a power tool on the weight of labor, as their coercive force is applied to the human hand, and from there it transmits and influences each the elements (hand, body, leg, base) of the power chain - the system of muscles, bones and joints of man.

2. POWER ANALYSIS FOR HANDLING ELECTRICAL TOOLS

2.1. Plan of the acting forces on handling electrical tools

The plan of the acting forces on handling electrical tools is presented in Figure 1.

2.2. Distribution of forces according to axial force direction F_{OC} during drilling and short characterization of the working posture

Depending on the positional distribution of the two connecting external forces (axial force F_{OC} at drilling and the weight G of the power tool) relative to the direction $n-n$, which is normal to the machined (face) surface of the object of action, the magnitude of the F_{PAE} equivalent force that the worker has to apply during processing is obtained [5,6].

Figure 1. Plan of the acting forces on handling electrical tools (position 2)
 F_{axial} – axial force when drilling, G – weight of the power tool, G_n – projection of G on the n - n direction, F_{work} – force applied by the operator's hand when drilling, α – angle of inclination of the tool axis with respect to the vertical axis Y

Position 1 ($\alpha = 0^\circ$)	Distribution of forces

<p>Most unfavorable working position (ceiling performance) due to:</p> <p>(1.1) Positioning of the object at a higher level than the working shoulder and perpendicular to the axis of the body, causing uncomfortable placement of the body - with a backward inclined head and arms raised forward and upward;</p> <p>(1.2) Maximum force response F_{work} – as the sum of the axle force F_{axial} and the weight G of the instrument;</p> <p>(1.3) Need to take precautions against the risk of dust, chips and other mechanical elements from drilling in the eyes and/ or face of the worker.</p>	

Position 2 ($\alpha = 45^\circ$)	Distribution of forces

<p>Unfavorable working position due to:</p> <p>(2.1) Similar to (1.1);</p> <p>(2.2) Significant forceful opposition F_{work} – as the sum of axial force F_{axial} and the projection of the weight G_n of the tool on the axis $n - n$;</p> <p>(2.3) Need to take precautions against the risk of dust, chips, etc. mechanical elements of the drilling in the eyes and/ or face of the worker.</p>	

Position 3 ($\alpha = 90^\circ$)	Distribution of forces
<p style="text-align: right;">$n \equiv X$</p>
<p>Favorable working position due to:</p> <p>(3.1) Ability to occupy a steady positioning of the body and hands in a straight posture;</p> <p>(3.2) Ability to more evenly distribute the applied force effect F_{work} between the hands and body of the worker;</p> <p>(3.3) Less force response F_{work} only obtained by the axial force F_{axial} because the tool's weight G is in a direction perpendicular to the axis n-n.</p>	
Position 4 ($\alpha = 135^\circ$)	Distribution of forces

<p>Favorable working position due to:</p> <p>(4.1) As with (3.1), but it necessitates some bending of the body forward at an angle;</p> <p>(4.2) As with (3.2);</p> <p>(4.3) Quite a less powerful F_{work} response, obtained as a difference from the axial force F_{axial} and the projection G_n on the weight G on the n-n axis.</p>	

Position 5 ($\alpha = 180^\circ$)	Distribution of forces

<p>The most favorable working position due to:</p> <p>(5.1) As with (3.1), but it forces a certain bending of the body forward;</p> <p>(5.2) As with (3.2);</p> <p>(5.3) Minimum force response F_{work}, obtained as a difference from the axle force F_{axial} and the weight G on the axis $n - n$;</p> <p>(5.4) When positioning the subject at a significantly lower level, it is necessary to occupy a heavier forward position of the body causing a risk of diseases in the waist area.</p>	

2.3. Determination of axial force F_{axial} when drilling and the weight G of the tool

Axial force F_{axial} when drilling is determined by the following formula [1,2]:

$$F_{axial} = 9,81 \cdot C_F \cdot D_F^q \cdot S_F^Y \cdot K_F \quad (1)$$

where C_F is a coefficient that depends on the material being processed; $C_F = 68$ for steel 45

със $\sigma_B = 60 \cdot 10^7$ Pa и HB = 156 – 207;

$D = 6$ mm – diameter of the drilled hole;

$S = 0,06$ mm/r – submission the tool when drilling;

$q_F = 1$ – exponent – for steel 45;

$Y_F = 0,7$ – exponent;

$n_F = 0,75$ – exponent;

K_F – coefficient.

$$K_F = (\sigma_B/75)^{n_F} \quad (2)$$

$$K_F = (60/75)^{0,75} = 0,846.$$

$$F_{axial} = 9,81 \cdot 68 \cdot 6 \cdot 0,139 \cdot 0,846 = 470,7 \text{ N} = 47,0 \text{ kg}$$

$G = 3,3$ kg – weight of the power tool – on an electrically-powered hand-held model BZ – 16D with power 650 W, producing a company ELTOS- Lovech [3,4].

2.4. Power Distribution of F_{work} according to the positioning angle α

The magnitude of the power F_{work} is determined by the magnitude of the positioning angle α of the formula (3):

$$F_{work} = F_{axial} \pm G_n = F_{OC} \pm G \cdot \cos \alpha \quad (3)$$

Table 1. Size of power F_{work} according to the positioning angle α

α	0°	30°	45°	60°	90°	120°	135°	150°	180°
F_{axial}, kg	47,0	47,0	47,0	47,0	47,0	47,0	47,0	47,0	47,0
G_n, kg	+3,300	+2,858	+2,333	+1,650	0,00	-1,650	-2,333	-2,858	-3,300
F_{work}, kg	50,300	49,858	49,333	48,650	47,000	45,350	44,666	44,142	43,700

2.5. Relative increase in the power ΔF_{work}

$$\Delta F_{work} = (F_{max} - F_{min}) / F_{min} \cdot 100 \% \quad (4)$$

where F_{max} is the maximum value of the force F_{work} ; $F_{max} = 50,3 \text{ kg}$ при $\alpha = 0^\circ$;
 F_{min} - the minimum value of the force F_{work} ; $F_{min} = 43,7 \text{ kg}$ при $\alpha = 180^\circ$.

$$\Delta F_{work} = (50,3 - 43,7) / 43,7 \cdot 100 = 15,1 \%$$

As a result of the conducted study, the following conclusions are necessary:

1. With increasing the value of the α angle from 0° to 180° , the resultant force F_{work} decreases from its maximum to the minimum due to the decrease in the size of the component G_n of the weight of the tool G along the $n - n$ axis and the change in the axial force direction F_{axial} .
2. Changing the value of angle α from 180° to 0° requires an employee to get an increasingly disadvantageous working position. This contributes to the emergence of additional technogenic risk factors requiring additional preventive measures.
3. The significant relative increase (by 15.1%) of the power F_{work} , applied by the drilling operation due to the change in angle α , contributes to an increase in the severity of work and a reduction in working capacity, especially when performing multiple operations.

3. CONCLUSIONS

With the present work, the authors propose a new approach to risk prevention for the safety and health of workers by force analysis when performing a drilling-assembling drilling operation. This approach is achieved:

- Combination of the process of technological design of plumbing-assembling operations with the process of ensuring safe and healthy working conditions in the working environment;
- Optimizing the organization of work through:
 - Presentation of preventive measures for correct and safe positioning of the system "worker - subject of influence";
 - Introduction of safe working and rest periods, according to the specifics of the workplace, the elements of the technological system and the nature of the activity.

4. REFERENCES

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