Optimization of parameters and regimes for excavator with replaceable milling head

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ABSTRACT

The issue of increasing the efficiency of the single-bucket excavator with the replaceable milling head during earthworks in transport construction are considers in the paper. The optimal parameters and operating modes depending on the soil strength are substantiated based on the analysis of technological schemes and graph-analytical dependencies. The proposed approaches provide the increase in performance by 12–18% and the reduction in specific energy consumption by up to 15%.

Keywords: excavator, milling head, parameter, operating mode, performance, optimization, earthworks.

1. INTRODUCTION

Modern requirements for transport construction provide for the reduction in the time required for earthworks, while reducing energy consumption and improving the quality of soil processing [1]. The replaceable milling heads use on the basis of the single-bucket excavator allows you to expand its functionality, combining operations for development, planning, crushing and loosening non-metallic materials. However, the use effectiveness of such equipment largely depends on the optimal select of parameters and operating modes.

2. EXCAVATOR PARAMETERS AND REGIMES

Necessary to take into account the mutual impact of the cut soil layer thickness, the working movement speed, the soil resistance and the drive power to achieve a rational combination of performance and energy efficiency. The comprehensive analysis of these factors in the form of technological work schemes and graph-analytical dependencies creates the basis for determining the optimal operating modes of the excavator with the replaceable milling head.

The replaceable milling head use on the single-bucket excavator makes it possible to realize the number of technological work schemes [2–5].

Opening of underground engineering networks (Fig. 1, *a*). The precise removal of the soil layer above the communications is performed, which minimizes the damage risk of pipelines and cable networks. The controlled soil layer thickness is ensured with high safety for engineering networks due to adjust the cutting depth.

Planning the walls and bottom of trenches (Fig. 1, *b*). The replaceable milling head forms the flat surface with specified profile parameters, which is important for ensuring design marks when laying pipes and collectors.

Planning of pit slopes (Fig. 1, *c*). The technology allows profiling at the desired angle with high accuracy, which reduces the amount of manual work and increases the stability of slopes.

Loosening and crushing of non-metallic materials (Fig. 1, *d*). The replaceable milling head ensures effective destruction of the material structure during operation with dense soils. If loosening frozen soil in the confined space, for example, in the railway carriage, the machine is positioned at the acceptable distance from the platform.

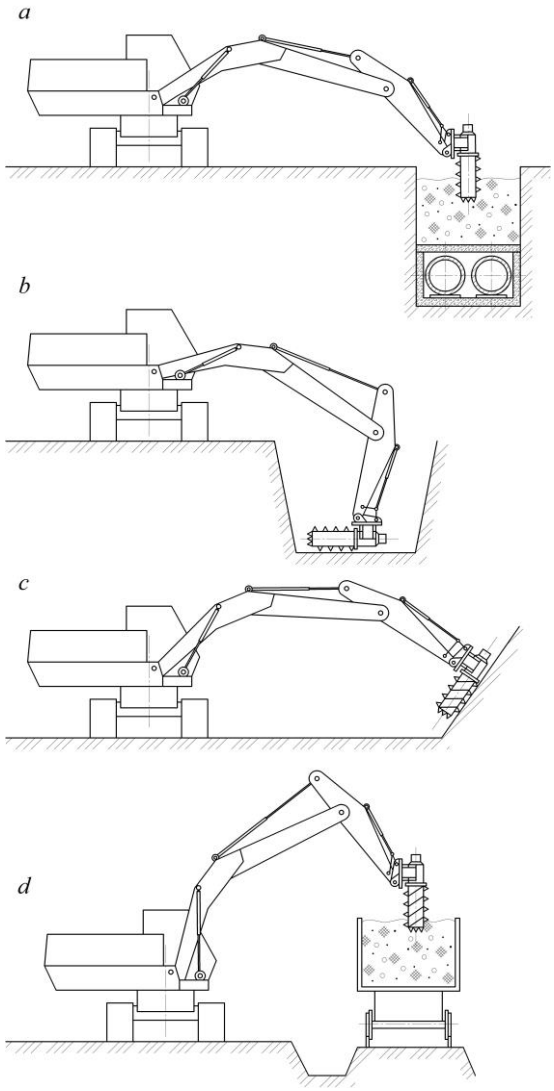

Figure 1. Technological work schemes of the excavator with the replaceable milling head: *a* – opening of underground engineering networks; *b* – planning of walls and bottom of trenches; *c* – planning of pit slopes; *d* – loosening of non-metallic materials

The efficiency of the single-bucket excavator with the milling head is determined by the consistency of the working element geometric parameters, the soil physical and mechanical properties and the selected cutting modes (Fig. 2) [1, 6].

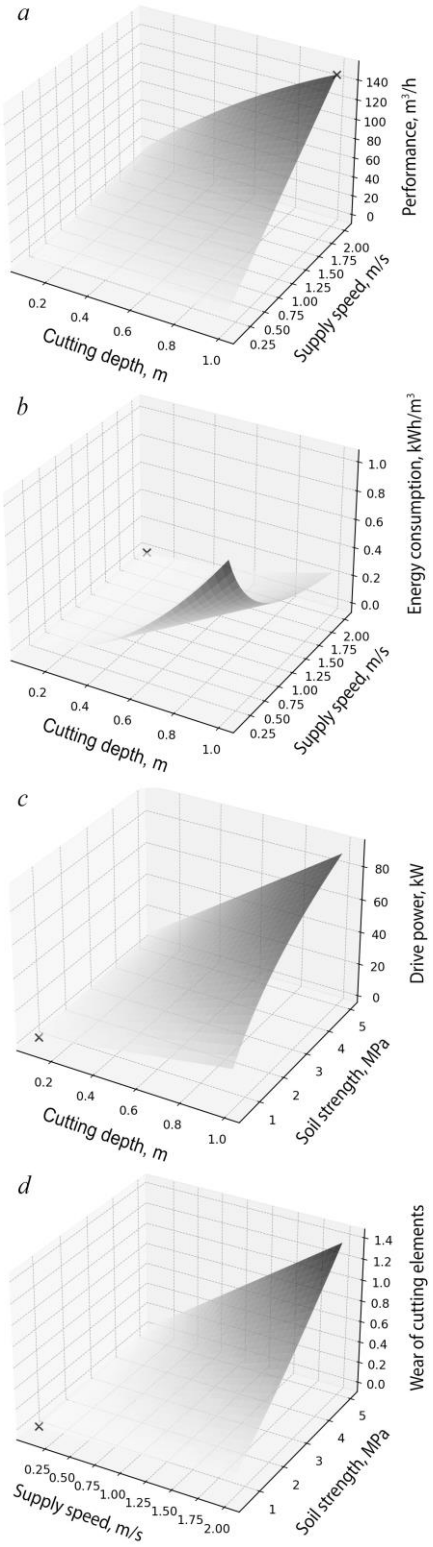

Figure 2. Spatial dependences of performance (*a*), specific energy consumption (*b*), drive power (*c*) and wear of cutting elements (*d*) of the replaceable milling head

The analysis of spatial dependencies showed: with an increase in the soil layer thickness over 0.30 m, energy consumption increases sharply, but performance increases by only 5–7%; the optimal working movement speed is 0.5–0.6 m/s, which allows maintaining the drive power at the level of 120–135 kW; the best ratio between performance and energy consumption is achieved with soil strength to 2.0–3.0 MPa; in the specified range, specific energy consumption decreases to 0.045–0.050 kWh/m³.

3. CONCLUSIONS

The replaceable milling head use expands the functionality of the excavator and increases the versatility of the machine set for earthworks. Optimization of parameters and operating modes allows you to ensure maximum performance with minimal specific energy consumption.

Graphical dependencies and projections of optima onto the planes (cutting depth – supply speed – soil strength) are the effective tool for engineering calculations and the selection of operating modes in the practice of transport construction.

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