

# DETERMINATION OF THE ANNUAL ECONOMIC EFFICIENCY OF VIBRATING ROLLERS COMPENSATION

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## Abstract

The article presents the economic efficiency indicators achieved as a result of implementing the technological process of one of the compaction machines, the road roller, based on the basic and new recommendations, expressions for determining the parameters involved in ensuring these indicators are given. When calculating the economic efficiency, the technological parameters of the compacting machines and soil properties were taken into account, and indicators were determined for each type of soil.

**Keywords:** Compacting machine, soil type, average speed, number of passes, soil layer, work productivity, comparative costs, product unit price.

## Introduction

As is known, in recent years, many reforms have been carried out in transport and communication networks, in particular, in the development of the road sector. A lot of work is being done to repair existing roads and build new ones. Due to the complexity of road construction, many road construction machines require the implementation of many technological processes [1,2]. Among them, the compaction stage is of great importance. Especially among the structural elements of the road structure, compaction of the roadbed soil at the required level ensures the long-term operation of the entire road.

## LITERATURE ANALYSIS

One of the main technical and economic efficiency criteria for compacting the roadbed with vibratory rollers is the productivity of the machine being used. The basic equipment is a combined vibratory roller with a mass of 14 tons, manufactured in our country. The use of these rollers for clay soils at the final stage of compaction is noteworthy.

As a practical result of operating the rollers in an energy-efficient mode, the increase in the efficiency of the machine in its work is ultimately expressed in an increase in productivity. To determine the effectiveness of the proposed method, we will conduct a comparative comparison of the productivity of the rollers. The use of various types of vibrating rollers ensures a cyclic process in compacting roadbed soils. The end result is to ensure the required compaction



coefficient of the roadbed layers [3]. In recent years, digital and intelligent methods have been used to determine the quality of compaction of roadbed soils [4,5].

As a given data, the annual performance of the vibrating roller of the XS143J combined roller manufactured at the UzXCMG joint venture with a mass of 14 tons is determined using the basic and new recommended operating parameters. Based on the conducted studies, the layer thickness for compacting sandy and loamy soils with the XS143J vibratory roller was established so that the required compaction coefficient was 0.98.



Fig.1. Combined vibratory roller. (XS143J 14000 kg).

#### RESEARCH METHODOLOGY.

Table 1 shows the number of passes required to achieve the required compaction coefficient, the average working speed for compacting sandy and loamy soils at optimum moisture, the layer thickness to be laid based on the basic recommendations and new recommendations based on the conducted studies.

Table 1 XS143J mass 14000 kg vibratory roller mode parameters

Parameter	The thickness of the soil to be covered, m		Number of passes required		Working speed m/h	
	Loam	Sandy loam	Loam	Sandy loam	Loam	Sandy loam
Basic recommendations	0,35	0,45	8	8	3100	7200
New recommendations	0,5	0,55	8	8	3100	7200

The operating performance of the road cat is determined by the following expression:[6]

$$\Pi = \frac{L_{len.} \cdot (B - \xi) \cdot h \cdot k_v}{\left(\frac{L_{len.}}{g} + t\right) \cdot n_p} \quad (1)$$

here  $L_{sec}$  - the length of the condensing section (200 m);

$B$  - the width of the compacting strip or the width of the roller, (UzXCMG  $m=14000$  kg,  $B=2,13$  m), m;

$\xi$  -the distance to cover the traces of the coil, m ( $b=0,3$  m);

$h$  - thickness of the layer of the ground, loam or sandy loam soil being laid, m ( $h=0,3-0,45$  m) ;

$k_v$  - time utilization rate;(  $k_v=0,85$ ).

$g$  - the average working speed of the roller [7] ;

$t$  - the time spent on turning the cage at the end of the section; ( $t = 0,2s$ ), s.

$n_p$  - number of passes required to achieve standard density. ( $n_p = 8$ )

## DISCUSSION AND RESULTS

When determining work productivity, we determine the indicators given by expression (1) for sandy loam and loamy soils.

On some recommendations

For loam soil

$$\Pi_l = \frac{200 \cdot (2,13 - 0,3) \cdot 0,3 \cdot 0,85}{\left(\frac{200}{3100} + 0,2\right) \cdot 8} = \frac{93,3}{2,11} = 44,2 \text{ m}^3/\text{h}$$

For sandy loam soil

$$\Pi_{s.l.} = \frac{200 \cdot (2,13 - 0,3) \cdot 0,4 \cdot 0,85}{\left(\frac{200}{7200} + 0,2\right) \cdot 8} = \frac{124,4}{1,82} = 68,35 \text{ m}^3/\text{h}$$

According to new recommendations

For loam soil

$$\Pi_l = \frac{200 \cdot (2,13 - 0,3) \cdot 0,35 \cdot 0,85}{\left(\frac{200}{3100} + 0,2\right) \cdot 8} = \frac{108,8}{2,11} = 51,6 \text{ m}^3/\text{h}$$

For sandy loam soil

$$\Pi_{s.l.} = \frac{200 \cdot (2,13 - 0,3) \cdot 0,45 \cdot 0,85}{\left(\frac{200}{7200} + 0,2\right) \cdot 8} = \frac{139,9}{1,82} = 76,9 \text{ m}^3/\text{h}$$

The number of working hours per year

$$T_y = (T_q - n_{d.b.}) \cdot t_{sm} \cdot K_{sm}, \quad (2)$$

$$n_{d.b.} = D_d + D_b + D_i, \quad (3)$$

$$T_y = (T_q - D_d - D_b) \cdot t_{sh} \cdot K_{sh}, \quad (4)$$

here  $T_q$  -the duration of the construction season for Surkhandarya and Kashkadarya regions is 195 days.

$n_{n.d.}$  - number of days without the possibility of rest ,holidays and work;

$D_{d.off}$  -number of days off;  $D_{d.off} = 48$  day;

$D_{f.d.}$  - number of feast days;  $D_{f.d.} = 10$  day;

$D_{n.op.}$  - days when there is no opportunity to do work;  $D_{n.op.} = 8$  day;

$t_{s.d.}$  -shift duration,  $t_{s.d.} = 8$  hours.

$$T_y = (195 - 48 - 10 - 8) \cdot 8 \cdot 1,5 = 1548 \text{ hour}.$$



The annual operational productivity is determined by this expression

$$\Pi_{o.p...} = \Pi_o \cdot T_y \cdot k_t, \quad (5)$$

where  $k_t$  - the coefficient of use of the cat in the ground by time

Based on recommendations

For loam soil

$$\Pi_o^{b.l} = 44,2 \cdot 1548 \cdot 0,85 = 58158,3 \text{ m}^3/\text{year}$$

For sandy loam soil

$$\Pi_o^{b.s.l} = 68,35 \cdot 1548 \cdot 0,85 = 89934,93 \text{ m}^3/\text{year}$$

According to new recommendations

For loam soil

$$\Pi_o^{n.l} = 51,6 \cdot 1548 \cdot 0,85 = 67895 \text{ m}^3/\text{year}$$

For sandy loam soil

$$\Pi_o^{n.s.l} = 76,9 \cdot 1548 \cdot 0,85 = 101185,02 \text{ m}^3/\text{year}$$

We determine the coefficient of interchangeability (technical equivalence) from the following formula:

For loam soil

$$Q = \frac{\Pi_o^{y.l}}{\Pi_o^{b.l}}, \quad (6)$$

$$Q = \frac{67895}{58158,3} = 1,16$$

For sandy loam soil

$$Q = \frac{\Pi_o^{y.s.l}}{\Pi_o^{b.s.l}}, \quad (7)$$

$$Q = \frac{101185,02}{89934,93} = 1,12$$

2. Estimated comparative costs.

$$K_c = \frac{P \cdot K_{tr}}{\Pi_{o.y.}}, \quad (8)$$

here  $K_{tr}$  - is the coefficient taking into account the costs of transporting the machine from the factory,

$$K_{tr} = 1,05 \dots 1,07;$$

$P$  – the price of the roller (UzXCMG m=14000 kg; from 576214560 soums to 603600000 sum.

Based on recommendations

For loam soil

$$K_c^{b.l} = \frac{589907280 \cdot 1,06}{58158,3} = 10751,7 \text{ sum m}^3;$$

For sandy loam soil

$$K_c^{b.s.l} = \frac{589907280 \cdot 1,06}{89934,93} = 6952,8 \text{ sum /m}^3.$$



According to new recommendations

For loam soil

$$K_c^{n.l.} = \frac{589907280 \cdot 1,06}{67895} = 9209,8 \text{ sum /m}^3;$$

For sandy loam soil

$$K_c^{n.s.l.} = \frac{589907280 \cdot 1,06}{101185,02} = 6179,7 \text{ sum /m}^3.$$

Machine shift price for XCMG XS 143J roller :

$$P_{sh} \approx t_{sh..} \cdot N_{mot..pr.h.}, \quad (9)$$

$$P_{sh} \approx 8 \cdot 349830 = 2798640 \text{ sum.}$$

$N_{mot..pr.h.}$  - motorcycle watch price.

Product unit price.

$$U_{u.p.} = \frac{P_{sh}}{P_{sh}^v}, \quad (10)$$

here  $P_{sh.p.}^v$  - shift productivity of the roller, m<sup>3</sup>/shift

$$P_{sh.p.}^v = t_{sh} \cdot \Pi_{o.p.}, \quad (11)$$

Based on recommendations

For loam soil

$$P_{sh}^v = 8 \cdot 44,2 = 353,6 \text{ m}^3/\text{shift.}$$

$$U_{u.p.} = \frac{2798640}{353,6} = 7914,7 \text{ sum /m}^3.$$

For sandy loam soil

$$P_{sh}^v = 8 \cdot 68,35 = 546,8 \text{ m}^3/\text{shift.}$$

$$U_{u.p.} = \frac{2798640}{546,8} = 5118,2 \text{ sum /m}^3.$$

According to new recommendations

For loam soil

$$P_{sh}^v = 8 \cdot 51,6 = 412,8 \text{ m}^3/\text{shift.}$$

$$U_{u.p.} = \frac{2798640}{412,8} = 6779,6 \text{ sum /m}^3.$$

For sandy loam soil

$$P_{sh}^v = 8 \cdot 76,9 = 615,2 \text{ m}^3/\text{shift.}$$

$$U_{u.p.} = \frac{2798640}{615,2} = 4549,1 \text{ sum /m}^3;$$

Cost comparisons for comparable cars:

$$Z_{com} = U_{u.p.} + K_{eff.} \cdot K_c, \quad (12)$$



$K_{sam}$  - normative coefficient of efficiency,  $K_{sam} = 0,15$

Based on recommendations

For loam soil

$$Z_{com}^{b.l.} = 7914,7 + 0,15 \cdot 10751,7 = 9527 \text{ sum /m}^3;$$

For sandy loam soil

$$Z_{com}^{b.sl.} = 5118,2 + 0,15 \cdot 6952,8 = 6161,12 \text{ sum /m}^3.$$

According to new recommendations

For loam soil

$$Z_{com}^{n.l.} = 6779,6 + 0,15 \cdot 9209,8 = 8161,07 \text{ sum /m}^3;$$

For sandy loam soil

$$Z_{com}^{n.sl.} = 4549,1 + 0,15 \cdot 6179,7 = 5476,055 \text{ sum /m}^3.$$

Economic efficiency

For loam soil

$$E_l = (Z_{com}^{b.l.} - Z_{com}^{n.l.}) \cdot \Pi_{o..}^{y.l.} \quad (13)$$

$$E_l = (9527 - 8161,07) \cdot 67895 = 92739817,4 \text{ sum /year.}$$

For sandy loam soil

$$E_{s.l} = (Z_{com}^{b.s.l.} - Z_{com}^{n.s.l.}) \cdot \Pi_{o..}^{y.s.l} \quad (14)$$

$$E_{s.l} = (6161,12 - 5476,055) \cdot 101185,02 = 69318315,7 \text{ sum /year.}$$

## CONCLUSIONS AND SUGGESTIONS

According to the new recommendations based on the calculation method discussed above, the annual economic efficiency values for compacting loamy and sandy soils were determined by introducing rational parameters for compacting roadbed soils. The annual economic efficiency for the XS143J vibratory roller for the construction of 200 meters of roadbed was 92739817,4 sum for loam and 69318315.7 sum for sandy loam.

## References

1. Komilov S.I. Distinctive features of vibrational compaction of subgrade soils with rollers "International multidisciplinary journal for research development" Volume 12, issue 05 (2025). 678 - 683 p.
2. Khankelov T.K., Khudaykulov R. M. Komilov S.I. Technological processes, stages and criteria for the construction of roadbed embankments. "Scientific Journal of Mechanics and Technology". 2024 No. 3, pp. 74-85.
3. Makhmutov M.M., Sakhapov R.L. On the quality of compaction of subgrade soils. Technology and organization of construction. Izvestiya KSUACE, 2015, No. 2 (32). pp. 289-294.
4. Manik Barman, Moeen Nazari, Syed Asif Imran, Sesh Commuri, Musharraf Zaman, Fares Beany, Dharamveer Singh. Quality control of subgrade soil using intelligent compaction. Innov. Infrastruct. Solut. (2016) 1:23. p.1-14. DOI 10.1007/s41062-016-0020-0.
5. Mooney M.A. Robert V. Rinehart, Norman W. Facas, Odon M. Musimbi Intelligent Soil Compaction Systems // NCHRP Report 676 .- Washington, D. C., 2010.- 166 p.



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6. Permyakov, V. B. Technological machines and complexes in road construction (industrial and technical operation): Publishing house of SibADI, 2007. - 440 p.
  7. S.V. Saveliev I.K., Poteryaev B.A. Razdobarin. Performance of road rollers in compaction of earth embankments of highways. Bulletin of Bauman Moscow State Technical University. Series: Mechanical Engineering. 2024. No. 3. pp. 90-100.

