The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 04 Pages: 58-67
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

Journal Website: https://theamericanjournals.com/index.php/tajet

Research Article

DEVELOPMENT AND EXPERIMENTAL RESULTS OF A NEW CONSTRUCTION OF THE ELEMENT OF PROTECTION OF THE BASE OF THE JAVE PART OF QUARRY EXCAVATORS

Submission Date: April 09, 2022, Accepted Date: April 17, 2022,
Published Date: April 30, 2022 |
Crossref doi: https://doi.org/10.37547/tajet/Volume04Issue04-05

Galiya Yeleubaevna Raykhanova
Republic of Uzbekistan, Tashkent region, Almalyk, Totuvlik str. 9-31, Uzbekistan

Rustam Umarhanovich Djuraev
Republic of Uzbekistan, Navoi region, Navoi, Spitamen str., 8 - 21, Uzbekistan

Sardorjon Abdumuminovich Turdiyev
Republic of Uzbekistan, Navoi region, Karmana, Bahor str., 39, Uzbekistan

ABSTRACT

An analysis of the performance of quarry hydraulic excavators shows that many excavators used in mining operations operate at lower productivity than those specified in the technical description. This can be caused by unexpected interruptions during operation, rapid failure of parts and unreliable operation of excavator personnel.

This article discusses the development of a protective element at the base of the jaw section of an excavator bucket that is technically and cost-effective in increasing the efficiency of quarry excavators. In addition, the results of experiments and their analysis of the proposed element of the protection of the base of the improved bucket jaw.

KEYWORDS

Quarry excavator, collapse size, bucket, jaw, protection element, durability, test, performance indicator, rhombus.

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 04 Pages: 58-67
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

INTRODUCTION

In solving the problems of quarry excavators in excavation and loading, it is important to consider the construction of these bucket elements, one of the parts of which creates a high load with rocks of various physical and mechanical properties. This leads to the appearance and development of the following types of defects:

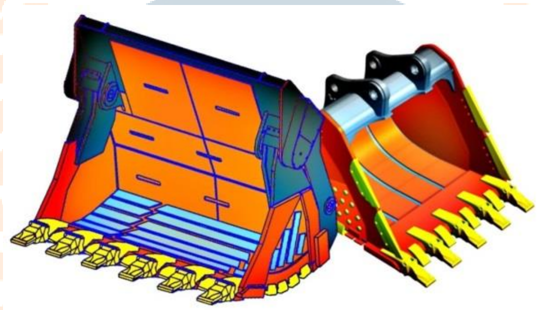
- Deformation of the walls on the inside and outside;
- Deformation of connected parts and technological holes (critical change);
- A change in the geometry developed by the manufacturer, ie a shift forward or backward relative to the central axis.

In all these cases, the excavator bucket needs to be repaired, which consists of lining (i.e. covering the worn surfaces with a protective layer), closing the cracks, replacing the jaw part, increasing the strength, repairing the defects and restoring the original shape.

MATERIALS AND METHODS

Repairs are carried out using milling and welding equipment (argon and electric arc), abrasive cleaning, grinding, final painting.

An overview of quarry hydraulic excavator buckets is shown in Figure 1 [1].



(a) is a straight shovel and (b) is a reverse shovel

Figure 1. General view of quarry hydraulic excavator buckets

Replacement parts that protect the bucket (lining, interdental and corner protectors) Hardox-400, -450, -500 steels, special corrosion-resistant coatings made of carbide alloys (coating plates ("ESCO"), CDP ("Messer Eutectic Castolin") "), as well as lining elements made of white chrome cast iron.

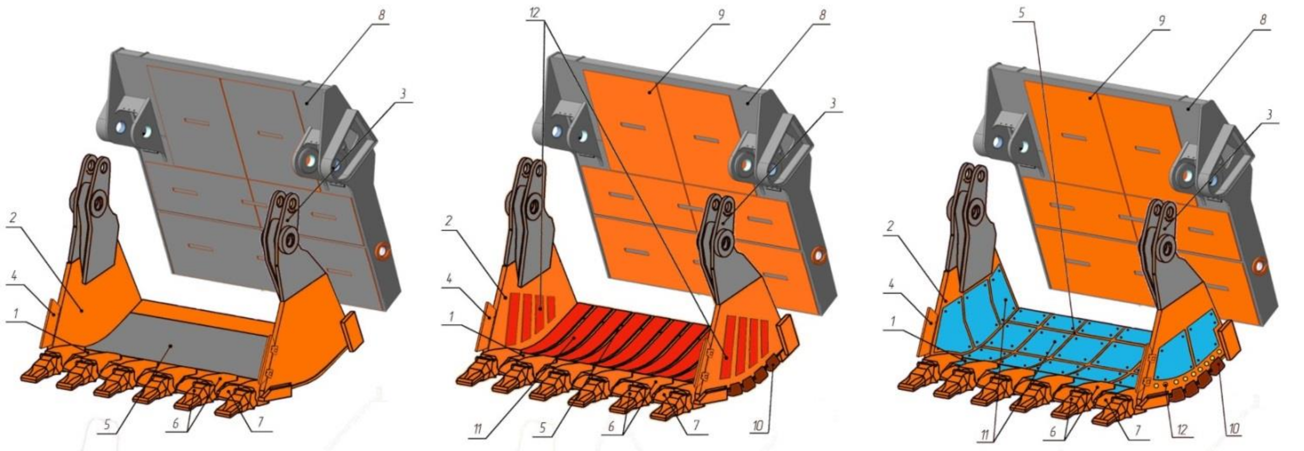
There are standard, reinforced, and highly reinforced types of protection for straight shovels, depending on where they are used [2].

The lightest bucket of the standard type without additional protection. Designed to work on less stable types of rock that do not require special protection (made of 10XSND, 09G2, Hardox steels) (Figure 2 a).

The bucket used in the reinforced quarries is additionally reinforced with Hardox-500 corrosion-resistant plates and other additional protective elements (made of Hardox, Hardox-HiTuf, Weldox steels). It can be used in many types of rocks (Figure 2b).

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 04 Pages: 58-67
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

The high-strength cast iron, in addition to the hardened cast iron, is protected by carbide alloy plates and cast elements made of white chrome cast iron. It is designed to work in particularly difficult conditions with high abrasiveness of high-density rocks (made of Hardox, Hardox-HiTuf and Weldox steels with protection from carbide alloys) (Fig. 2 v).



1 - cutting edge, 2 - side wall of the jaw part, 3 - fastening parts of the back and jaw part of the bucket, 4 - side cutter, 5 - lower part of the jaw, 6 - tooth system (adapter and tooth), 7 - protection element between teeth, 8 - body, 9 - body protection element, 10 - corner protection element, 11 - lower jaw and side wall protection element, 12 - external protection elements

Figure 2. Types of protection for straight shovels:

a - standard; b - reinforced; c - highly reinforced

Among the protective elements of the bucket discussed above, the parts that create a high load under the interaction with the rocks are the jaw part after the cutting elements [3].

The jaw is used as one of the key elements of a straight bucket quarry excavator, which is the moving element of the bucket. When the back wall of the bucket is in good condition and for additional economic savings, only the bucket jaw can be replaced separately. In order to increase the strength of the jaw structure and to resist abrasive erosion, additional internal and external castings made of high-strength steel with a hardness of 500-600 HB according to Brinell are used. It is equipped with teeth, adapters, interchangeable sturdy side cutters, a guard between the teeth with welded elements, welded elements to protect the corners of the lower part.

Quick breakdown of the jaw surface of quarry hydraulic excavators leads to an increase in the duration of repairs and costs [4].

The protection of straight shovels according to the place of use should increase the service life based on the reduction and elimination of erosion and damage of bucket parts, however, Quarry hydraulic excavators used in open pit mines of NMMC JSC The following factors have been identified by investigating the factors affecting the degradation rates of the protective elements of the 'section and the resulting faults.

As a result of the breakdown of the protective elements of the bucket part, the cutting edge of the bucket part does not pass, which results in fractures of the bucket part during operation, which is shown in Figure 3.

Figure 3. The fracture state of the cutting edge of the jaw

Analysis of the results of the above studies shows that most of the faults in the jaw part of the quarry hydraulic excavators used in open pit mining are insufficient protection elements of the jaw part, low strength and resistance to erosion, ie different types of excavated rock It quickly loses its properties when exposed to rocks, and as a result, the jaw part quickly erodes, leading to failure of other parts of the excavator and a decrease in operational performance [5].

In view of the above, it is important to develop technical solutions to increase the service life and efficiency of the jaw part elements of quarry hydraulic excavators.

THE MAIN PART

Today, quarry hydraulic excavators are equipped with special protective elements on the base and side walls to ensure that the jaw section is corrosion-resistant, durable and long-lasting. HITACHI EX-1200 quarry hydraulic excavators currently use plate-shaped coatings to protect the base of the jaw section, and the location and dimensions of the plate-based base coatings at the base of the bucket jaw section are shown in Figure 4 [6].

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 04 Pages: 58-67
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

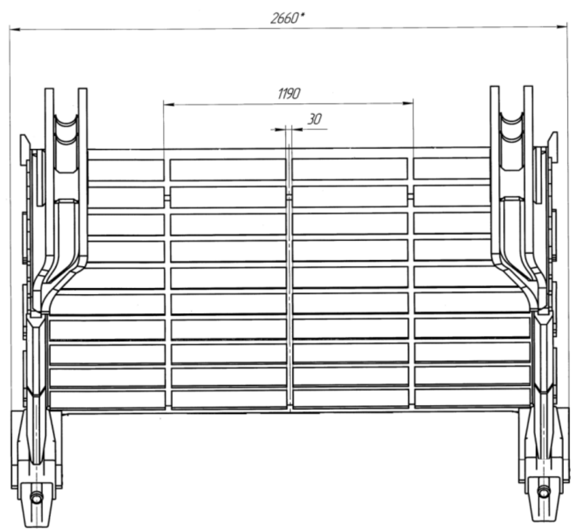


Figure 4. Location and dimensions of the base plates in the form of plates at the base of the jaw

As can be seen from Figure 4, 40 rectangular plates are welded to the base to protect the base of the jaw. Each plate weighs 6.9 kg, is 500 mm high, 100 mm wide and 14 mm high. The distance between each coating is 30 mm.

Currently, the service life of the above-mentioned protective element, which is used to prevent the collapse of the base of the jaw section of quarry excavators, is 30-35 days. This means that every 30-35 days, the excavator bucket requires re-coating of the jaw protection elements with new coatings. Repair work, on the other hand, increases operating costs as a result of labor time, labor, and materials required for welding (gas, electrodes) [7].

With the above in mind, it will be possible to increase the productivity of the excavator by reducing the operating costs of the excavator by increasing the durability and strength of the protective elements of the jaw part of the excavator bucket and producing a relatively lightweight improved design.

During theoretical and industrial studies, observations of the operation of the jaw part protection elements revealed the need to increase the strength of the base and side walls of the jaw part, which make the most contact with the rocks. To this end, an improved rhombus-shaped protective element has been developed to increase the efficiency of the quarry excavators 'operating mode, in exchange for increasing their resistance to collapse.

In the process of developing the protective elements, it was taken into account that large fragments of rock can withstand strong blows to the jaw and reduce erosion by leaving the crushed rock within the developed protective elements.

This improved protection element is designed to penetrate rock with a length of 700 mm and a width of 300 mm. listed.

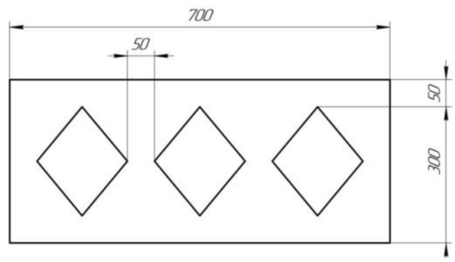


Figure 5. The rhombus-shaped jaw is a protective element

The length and width of the rhombuses are 200 mm and 173 mm, respectively. The distance between the rhombuses and the side wall is 50 mm. The height of the protection element is 20 mm.

12 of these protection elements can be installed on the base of the bucket jaw, and the location of the rhombus-shaped protection element on the base of the bucket jaw is shown in Figure 6. The distance between each protective element is 50 mm.

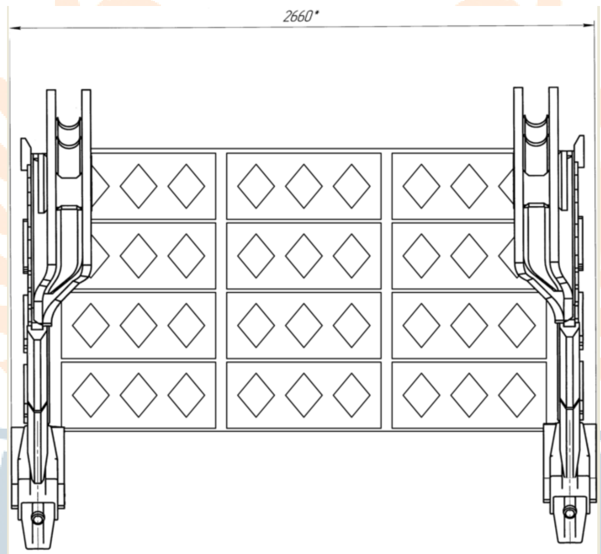


Figure 6. The rhombus-shaped protective element is located at the base of the bucket jaw

EXPERIMENTAL RESULTS

In order to determine the effectiveness of the new design of the protective element of the jaw part of the developed excavator bucket, they underwent experimental tests.

During the experimental work, the abrasion resistance of the protective elements of the base of the jaw part of the excavator bucket, ie their service life, was studied.

The following machines and equipment were used during the experiments:

- HITACHI EX-1200 Quarry hydraulic excavator;
- protective elements of the base of the base and rhombus-shaped jaw;
- electronic caliper;

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 04 Pages: 58-67
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

- Rocks with explosive hardness f = 12 ÷ 14.

The experimental work was carried out in the following stages:

In the first stage of the experimental test, the excavation was carried out during the excavation and loading operations, with the installation of protective elements in the form of a base plate at the base of the jaw section. During the experimental tests, it was determined that the thickness of the basic protective elements installed on the base of the bucket jaw during operation for a certain period of time.

In experimental tests, one of the most effective ways to determine the size change of the base protection element of the base of the bucket jaw due to frictional erosion due to its thickness during operation for a certain period of time is differential (micrometric) method Δ = 0.1 mm error was carried out using an electronic barbell caliper, which can be tolerated, and these results are given in Table 1.

Based on the results of the above experiments, the dependence of the service life of the protective element, which has a basic structure, on the base of the jaw part of the excavator bucket, is shown graphically in Figure 7 below.

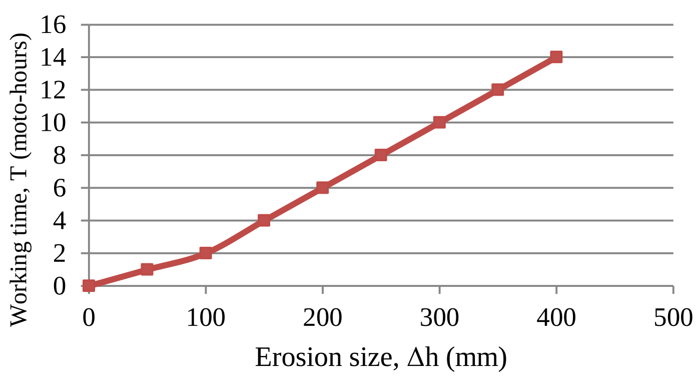


Figure 7. Graph of the magnitude of the breakdown of the basic protective element of the base of the jaw part

As can be seen from the graph of the dependence of the service life of the base protection element on the base of the bucket jaw section shown in Figure 7 above, an increase in the failure rate of the protection element is observed as the excavator service life increases.

The average lifespan of the jaw section of the excavator bucket was 400 moto-hours.

In the second stage of the experimental test, the developed rhombic bucket was implemented during the operation of quarry excavators with the installation of a protective element at the base of the jaw section, without changing the above parameters.

The magnitude of the amount of erosion caused by the friction of the rock during the full operation of the protective elements of the base of the developed rhombus-shaped jaw section during their full service

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 04 Pages: 58-67
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

life was measured, and these results are given in Table 1. 'shown.

Table 1

The amount of breakdown of the basic and developed protective elements of the base of the jaw part of the excavator bucket

Working time, moto-hours	The amount of degradation of the basic protective element Δh, mm	The height of the rhombus-shaped protective element Δh, mm
0	0	0
50	1,0	1,0
100	2,0	2,0
150	4,0	3,0
200	6,0	5,0
250	8,0	7,0
300	10,0	9,0
350	12,0	12,0
400	14,0	15,0
420	-	18,0
440	-	20,0

Also, the results of the performance of the new protective elements of the base of the jaw part of the excavator bucket, developed during the experimental work, mentioned in Table 1 above, and on the basis of these results improved the protective element of the base of the jaw part of the excavator bucket. the dependence of the service life of the developed rhombus-shaped structure on the magnitude of the collapse was established, and this dependence is shown in Figure 8 below.

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 04 Pages: 58-67
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

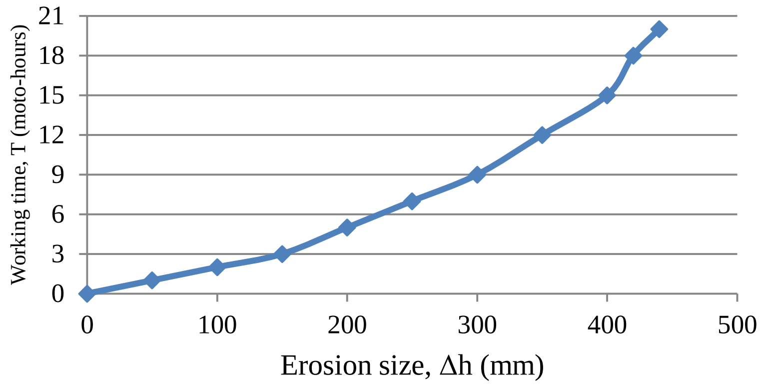


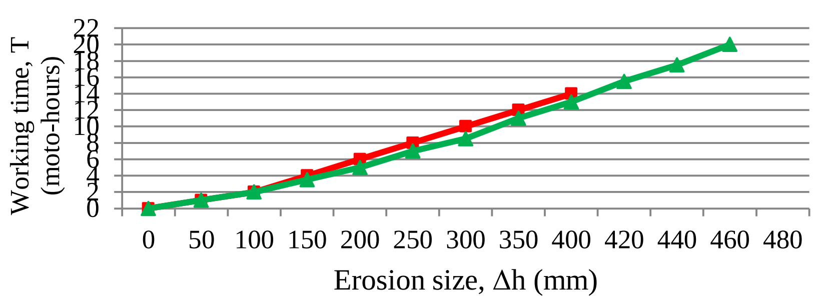
Figure 8. Graph of the magnitude of the deterioration of the service life of the improved rhombic protective element of the base of the jaw part

As can be seen from the graph of the dependence of the service life of the bucket jaw part with the improved rhombus shape shown in Figure 8 above, the rhombus-shaped bucket jaw as a result of the increase in service life every 50 moto-hours. The magnitude of the erosion on the thickness of the protective element of the base of the part was 1-2 mm during the initial working hours of the protective element, ie up to 250 moto-hours. During the next 250 to 460 moto-hours of operation, every 50 moto-hours was 3-5 mm.

The average lifespan of the jawbone of the excavator was 460 moto-hours.

CONCLUSION

Based on the results of the experimental studies, graphs of the magnitude of the collapse of the protective plate with the base plate and improved rhombic shapes of the base of the jaw section were established and their mutual comparison garden The gravity graph is shown in Figure 9.



1 - basic protection element; 2 - rhombus-shaped protective element

Figure 9. Graph of the basic and improved protective elements of the base of the jaw part of the excavator bucket depending on the rate of deterioration

The American Journal of Engineering and Technology
(ISSN – 2689-0984)
VOLUME 04 ISSUE 04 Pages: 58-67
SJIF IMPACT FACTOR (2020: 5. 32) (2021: 5. 705) (2022: 6. 456)
OCLC – 1121105677 METADATA IF – 7.856
Publisher: The USA Journals

As can be seen from the graph of the bucket jaw part protection elements with the basic and improved rhombus shape shown in Figure 9 above, the dependence of the magnitude of the fracture on the thickness of the working life is improved relative to the basic protection element. The working life of the protective element of the jaw part of the bucket with a rhombus shape was found to be 60 moto-hours, ie 15% more time performance, the jaw part is 24 kg lighter and consumes less metal.

REFERENCES

1. Gavrishev S. E. Rationale of organizational and technological methods for increasing the reliability and efficiency of open-pit mines: Ph: - Magnitogorsk, 2002. - 294 pt.
2. Poderny R.Y. Analysis of the current state of the quarry machinery market in the world // M.: Mining Industry, 2013. - №4 (110).
3. Turdiyev S.A and Jurayev A.Sh 2022. Study of the effect of excavator bucket tooth abrasion on digging resistance. Academic Research in Education Sciences. 3(3), pp. 105-110.
4. Abduazizov N.A., Mahmudov Sh.A., Turdiyev S.A. A study on the theory of the work of the working elements of hydraulic quarry excavators. Bukhara Engineering Technologists University. Discipline and technology development of a scientific and technical journal. 2021 il 3rd p.4-11.
5. Turdiyev S.A., Djurayev R.U., Jo`rayev A.Sh. Experimental and test study of the effectiveness of the improved design of the excavator bucket jaw plate // Central asian research journal for interdisciplinary studies (CARJIS) – Uzbekistan, 2022. – Volume 2, Issue 3. P. 214-223.
6. Turdiyev S.A., Djurayev R.U. Experimental results on the effectiveness of an improved excavator bucket tooth design // The American Journal of Engineering and Technology – America, 2022. – Volume 4, Issue 3. P 1-13.
7. Djuraev R.U., Turdiyev S.A. Mathematical modeling of the wear of cutting elements on quarry excavators // International journal of advanced research in science, engineering and technology (IJARSET) – India, 2022. – Volume 9, Issue 3. – P. 19074-19080.