Optimization of the Durability of SINOTRUCK HOWO-371 Truck Used in DARKHAN Steel Company

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Abstract: This study focusing on optimization of durability of the SINOTRUCK HOWO-371 dump truck used in mining of Darkhan steel company. Therefore, the parts unit costs in intervals with 5000 km mileages collected to determine the total unit costs variation depending on mileage or age of truck. Also, past years, the accumulation cost is determined by cost of new vehicle. Optimal durability of truck determined by minimum values of those two unit costs is 4.5 years

Key words: mining, norm, cost, DARKHAN, model, mileage

1. INTRODUCTION

Most of the mining companies, the transportation is subdivision of mining business. Also, there is little income with using many heavy trucks in mining because of resource and trade limitations. Most of the mining companies, as an implementing the service and repair work of heavy truck in field condition, the development of production – technical base of transport enterprise is slowing down, furthermore, heavy trucks lost their technical readiness and repair cost drastically increased because they used only method as changing a damaged parts. In case of the repair cost increases drastically, mining companies have policy which is buying a new truck to increase their income. By the law, the governmental and local organizations have to use vehicle more than 7 years before minus vehicle from fixed capital. Also, governmental organization will buy a new car after sold the old car that used for 7 years. The mining company has lost possibility to transport by new car while waiting more than seven years norm.

Goal of study is to increase an income of mining of Darkhan steel company by optimizing durability of SINOTRUCK HOWO-371 and implementing a new norm to withdraw vehicle from fixed capital. To accomplish the goal following tasks are decided.
*   Determine the variation of technical usage cost depending on vehicle age or mileage.
*   Determine the norm to withdraw vehicle from fixed capital.

2. METHOD SELECTION OF MATH MODELLING TO DETERMINE DURABILITY OF SINOTRUCK HOWO-371 TRUCK USED IN MINING OF DARKHAN STEEL COMPANY

The durability or norm to withdraw vehicle from fixed capital is determined by condition of traffic safety or economic efficiency (Gots, A.N. 2012).

The norm has lack economic efficiency because the norm determined by mileage l_o maintain a level $R_g = \gamma$ that indicates minimum possibility to work without breakage the system and units is too short. Those system and units will influence in traffic safety.

The second method to determine vehicle usage norm is minimizing a loss by falling down vehicle readiness (Kluev, V.V. 2003). To determine the norm by this method, calculation of company loss which got from vehicle stopped by technical failure is required. In mining division, loss by vehicle stop have determined by many methods. In case of Darkhan steel company seems got loss from market of raw iron ore or market of steel extracted from iron ore. But, in Darkhan steel company, determining a norm using this method is not possible because extraction process of steel is not start and company hasn't contract to sell iron ore.

Car readiness can keep with long time by repairing it as many time as because car is renewable integral system (Kopnov, V.A. 1999). Service and repair of trucks used in mining of Darkhan steel company are implemented in field condition. This case, the only methods used as a damaged parts changed by new parts because in field condition, but using a reconditioning process in service and repair is impossible. In field condition, quality of repair might be not good, damage frequency shortening and mileage between two damages are being short. The norm of new parts is short than original parts norm which equipped by car manufacturer. By the above two reasons, cost of repair for year is continuously increasing with car age became older.

Capital is accumulated year by year depending upon car purchased cost to establish found recovering an expense of car. Accumulation of one year will be decrease with increasing of norm because accumulation of one year is determined as expense of car which purchase in future divided by norm of car.

Norm will be determined by minimum of the total cost of those two costs. But, this method not used directly because car is not used permanently for year (Ziryanov, I.V. 2006). So, the real working condition of trucks used in mining is determined by its mileage. In this case, instantly, determining an optimal mileage is required to determine optimal norm of truck in mining of Darkhan steel company. Math model to determine the optimal mileage of truck to transport iron ore of mining is (1):

$$\min_{L \to L_{ON}} \left(\frac{E_T}{L}\right) = \min_{L \to L_{0N}} \left[\frac{E_{part}(L)}{L} + \frac{E_{acc}(L)}{L}\right] \tag{1}$$

where,

$\frac{E_T}{L}$ – Cost of car from initially used to mileage, L,

$\frac{E_{part}(L)}{L}$ – Cost of the part from initially used to mileage, L,

$\frac{E_{acc}(L)}{L}$ – Cost of accumulation of one year from initially used to mileage, L,

L- mileage of car from initially used time.

After determine optimal mileage, L_{ON} the optimal norm, T_{ON} is determined as follows (2):

$$T_{ON} = \frac{L_{ON}}{L_{YA}} \qquad (2)$$

where,

T_{ON}- optimal norm, time

L_{ON}- optimal mileage,

L_{YA}- average mileage for year.

The optimal mileage of SINOTRUCK HOWO-371 dump truck used in mining of Darkhan steel company is determined minimum cost in unit mileage.

3. RESEARCH METHODOLOGY AND RESULT

Mining of Darkhan steel company has totally 51 SINOTRUCK HOWO dump truck. In the report contains parts names and date of change, the part cost in mileage is registered at 5 thou.km intervals from initially used time and average values are show in table 1.

Table 1. Part cost of dump truck

№	Specification	Mileage Intervals from initially used time, thou. km							
		0÷5	5÷10	10÷15	15÷20	20÷25	25÷30	30÷35	35÷40
1	Total part cost at intervals, thou. ₮	19609	20700	29551	27697	25444	23100	18981	15554
2	Used car numbers at intervals	51	50	45	39	31	24	15	11
3	Average part cost at intervals, thou. ₮	384.5	414.0	556.7	710.2	820.8	962.5	1265.4	1414.0
4	Total part cost till each interval, thou. ₮	19609	40309	69861	97558	123003	146103	165084.	180638
5	Part cost at intervals, thou. ₮	76.8	82.8	111.32	144.4	164.16	192.5	253.08	280.3

There are no car with 40000 km mileage because all cars initially used from 2011. So, to predict part cost in mileage more than 40000 km the part cost depending on mileage of car is calculated by SPSS-16 standard program, as follows:

$$y = 3.85x^2 - 69x + 260 \qquad (3)$$

Ability of formula to meet that activity is estimated by Pearson's criteria and the interpreting strengths of correlations became 95% relationship.

To determine the optimal norm of dump truck that used in mining of Darkhan steel company, the calculation was made using a formula (3) for 8 years as a norm because of law which implemented in Mongolia.

Following values are predetermined to calculate accumulation of car by depending on mileage from initially used time; $C(1) = 120$, mil.₮. – initial expense of dump truck SINOTRUK HOWO-371, $E = 0.08$ – normative coefficient of investment income.

$C(t) = C(1) \cdot (1 + E)^{kt} = 120.000 \cdot (1 + 0.08)^t$ - Purchasing expense of new car after t years gone from initially used time of old and this depends on norm. Accumulation cost,

$\frac{3_{C \ni P}(L)}{L}$, depending on mileage of dump truck SINOTRUK HOWO-371 is determined by using following formula.

$$\frac{E_{acc}(L)}{L} = \frac{C(t)}{L(t)}$$
(4)

Here: $C(t)$- cost of new car past t years,

$\qquad$ $L(t)$-mileage in t years.

Costs determined by (3) and (4) formula and total cost are shown in table 2.

Table 2. Cost of parts

№	Cost type	5	15	25	35	45	55	65	75
1	Part cost, thou. ₮	94,0	118,5	171,9	240,7	315,9	418,3	555,9	699,6
2	Accumulation cost of parts, thou.₮/thou.km	24000	4000	1600	657	333	321	268	240
3	Total cost, thou.₮/thou.km	24094,0	4118,5	1771,9	897,7	648,9	739,3	823,9	939,6

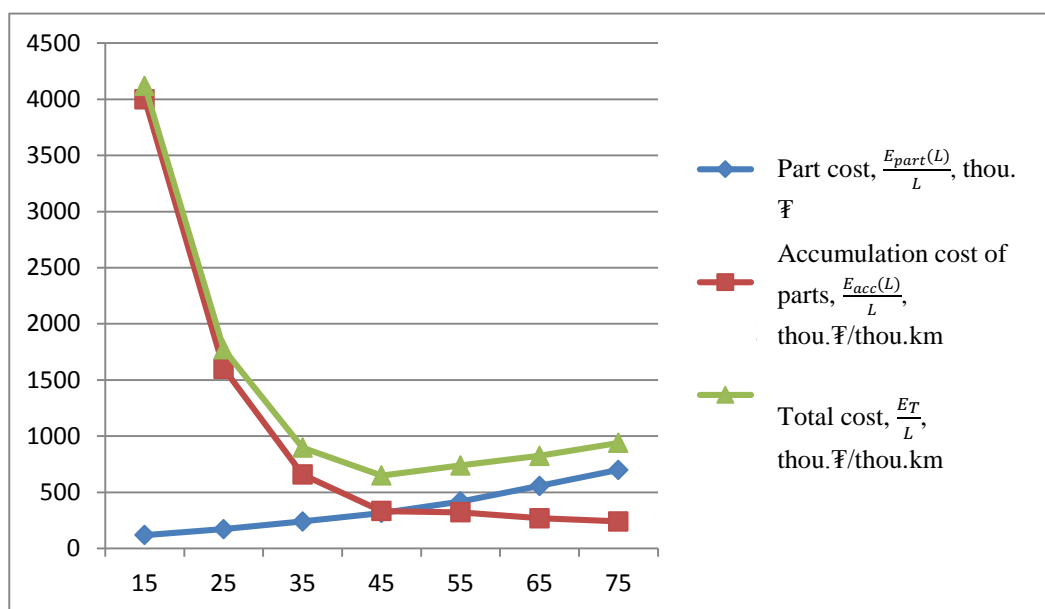To understand clearly, show it by diagram.

Figure 1. Unified diagram of costs

From the diagram and table, the minimum of total cost of SINOTRUCK HOWO – 371 dump truck is 648.9 648.9 thou.₮/thou.km. This cost is maintain 45 thou.km mileage or 4.5 years norm. Our neighborhood, in China, the norm of SINOTRUCK HOWO – 371 dump truck is determined as 8 years. In case of Russia, the norm of dump truck is 7 years. But those norms

are intend to the trucks which used in Construction Company and all service of truck made in Service Center.

CONCLUSION

1. The optimal norm of SINOTRUK HOWO-371 dump truck used in mining of Darkhan steel company is 4.5 years.
2. Renewing a norm to withdraw vehicle from fixed capital is required for heavy duty dump trucks that used in governmental mining company.

REFERENCES

Gots, A.N. (2012) Optimal durability of machine// New problems of science and education. № 3; URL: www.science-education.ru/103-6245 (in Russian).

http://otherreferats.allbest.ru/transport/00007116_0.html .

Kluev, V.V., Bolotin, V.V., Sosnin, F.R. (2003) Relaibility of the machine, *Engineering* IV-3, 592 pp. (In Russian)

Kopnov, V.A. (1999) Optimal degradation process control be two level policies // Reliability Engineering and System Safety, 66pp, 1.11.

Tests completed on new trucks at B.C. Coal mine// *Mining J*, 1990, 315, № 8094, 324 pp.

Ziryanov, I.V. (2006) Improving the effectiveness of heavy duty vehicles in extreme conditions. *Thesis of Doctor of Technical Sciences*. Sankt-Peterburg, 378 pp. (In Russian)