

A Survey of Failure in Mechanical Crankshafts of Automobile

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Abstract: In this study mechanical crankshaft failure for automobile is examined. This was done using data gathered by oral interviews and questionnaire administration on mechanical failure of crankshafts. The data collected were analysed using statistical methods based on probability. With this technique, probability of failure for each category of automobile considered-private, commercial cars and buses were evaluated. The results obtained showed that private cars enjoyed lowest failure rate at the initial stage while commercial buses had the highest failure rate. At the later periods all the categories considered had their failure rates very close to one another and at the same time they are insignificant (very small). At this point reliability gained its highest momentum. This showed that increased enlightenment campaign among the various stakeholders in automobile industries has gone a long way in improving reliability of mechanical crankshafts in automobile.

Key words: Crankshaft failure, statistical analysis, reliability, enlightenment campaign

INTRODUCTION

Transportation is a very important factor in the economy of every country as every business transaction is made possible by means of transportation through air, sea or land. In Nigeria and most developing countries transportation by land is mostly patronized especially using automobile such as lorries, buses, cars among others. Therefore automobile industry played a significant role in economic development in the developing country such as Nigeria in the areas of raw material and finished goods transportation from the industries to reach the final consumers. Improved performance of the transportation sector, therefore, definitely has positive effects on the countries' economy (Akinola and Ogedengbe, 2003).

In Nigeria, the development of automobile has had a very profound effect on the spatial organization of her economy. Simultaneously; automobile crankshaft failure and the associated problems have equally increased with the development in automotive industries as many brands/models of vehicles are on sale in the recent time (Askeland, 1993). Besides, the automobile crankshaft failure has led to increase in the death rate of people in the country through accident it caused and not only that it has also caused many citizens to be permanently disabled. Yet awareness campaign on automobile safety has received little or no encouragement compared to the awareness given to some killer diseases such as malaria, Acquired Immune Deficiency Syndromes (AIDS), tuberculosis infection among others, which have, in some cases, a tremendous low reported cases of death compared to death cases reported from automobile crankshaft failure (accident) (Ajieogwu, 2004).

It is a general believe that crankshaft failure has been on increase in recent years. The increase is attributed to rapid increase of car ownership, non-expansion of roads and disobeying of engine maintenance rule. Though there are monitoring agencies such as police, road safety corps among other to see to the implementation of the basic traffic rules but the level of monitoring and enforcement of these traffic rules is unknown especially one that related to crankshaft failure named 'maintenance' (Heinz, 1989).

In this study, the crankshaft automobile failure and its associated factors are investigated, examined and analysed to determine the level of monitoring and enforcement of maintenance rule that prevents premature failure of crankshafts.

The crankshaft is located below the cylinder on an in-line engine at the base V on a V-type engine and between the cylinder banks on a flat engine (Charles, 1994). As the pistons move up and down, then turn the crankshaft just like your legs move up and down to turn the crank that is connected to the pedals of a bicycle. The piston travels down, on the intake stroke, up, on the compression stroke, down, on the power stroke and up, on the exhaust stroke (Charles, 1994; Heisfer, 1995).

MATERIALS AND METHODS

The study was conducted by survey through questionnaire administration and oral interviews of selected crankshaft maintenance shops in Akure metropolis of Nigeria. The brands/models of vehicle covered in this research include Nissan, Datsun and other Japanese models which are used as private cars,

Table 1: Crankshaft failure for different mechanical companies (2000-2006)

k	Brand of vehicle specialised on	Maintenance workshop	i	No. sampled, S_i	No. of failure, f_i	Identified causes of failure
1	Nissan Datsun (Private cars)	AU mechanical workshop, Akure (A)	1	49	12	Oil leakage, overloading, adulterated oil, surface finishing of the thrust bearing, poor reconditioning.
			2	49	10	
			3	49	8	
			4	49	7	
			5	49	5	
			6	49	4	
			7	49	3	
2	All Japanese cars (Commercial cars)	AF maintenance workshop, Akure (B)	1	34	10	Oil leakage, improper oil supply to the engine system.
			2	34	8	
			3	34	6	
			4	34	2	
			5	34	1	
			6	34	3	
			7	34	4	
3	Commercial buses of all brands	OYG mechanical workshop, Akure (C)	1	98	30	Poor maintenance, bad oil filter and oil leakage.
			2	98	26	
			3	98	16	
			4	98	10	
			5	98	7	
			6	98	5	
			7	98	4	

Table 2: Probability of failure analyses

Years, t_i	i	Probability of failure			Cumulative probability		
		k=1 (A)	k=2 (B)	k=3 (C)	k=1 (A)	k=2 (B)	k=3 (C)
2000	1	0.25	0.29	0.31	0.25	0.26	0.31
2001	2	0.21	0.24	0.27	0.46	0.53	0.58
2002	3	0.16	0.18	0.16	0.62	0.71	0.74
2003	4	0.14	0.12	0.1	0.76	0.83	0.84
2004	5	0.10	0.09	0.07	0.86	0.92	0.91
2005	6	0.08	0.05	0.05	0.94	0.97	0.96
2006	7	0.06	0.03	0.04	1.00	1.00	1.00

Table 3: Probability of success (reliability analyses)

Years, t_i	Reliability or probability of success $R(t_i)$		
	k = 1 (A)	k = 2 (B)	k = 3 (C)
2000	0.75	0.71	0.69
2001	0.79	0.76	0.73
2002	0.84	0.82	0.84
2003	0.86	0.88	0.9
2004	0.9	0.91	0.93
2005	0.92	0.95	0.95
2006	0.94	0.98	0.96

commercial cars or buses. Private cars', commercial cars' and buses' crankshafts are maintained by maintenance shops namely AU, AF, and OYG mechanical workshops respectively. The actual names of the maintenance shops are concealed to safeguard their information and integrity. Crankshaft sampled for in each shop for each year starting from year 2000 are 49, 34 and 98, respectively depending on traffic density in each shop. Total number of crankshaft required reconditioning or rejected as a result of failure are recorded annually as appropriate for the three categories private, commercial cars and buses. Causes of failure of crankshafts were also identified through questionnaire administered. The data obtained from oral interview and questionnaire conducted are summarised in Table 1. Probability of crankshaft failure

$P^k(f_i)$ and its cumulative $P^k(f_i)_c$ were obtained using Eq. 1 and 2, respectively, while that of reliability or probability of success $R(t_i)$ was computed based on Eq. 3.

$$P^k(f_i) = f_i / S_i \quad (1)$$

$$P^k(f_i)_c = \sum_{i=1}^n p^k(f_i) \quad (2)$$

$$R^k(t_i) = 1 - P(f_i) \quad (3)$$

Where f_i is the number of crankshaft failure, S_i is the total number of crankshaft sampled, the indices i , and k denote number of year ($i = 1, 2, 3, \dots, n$) and crankshaft categories ($k = 1, 2, 3$), respectively.

The results obtained from the analyses of the data using the Equations above are presented in Table 2 and 3.

RESULTS AND DISCUSSION

It was found, in the research that many factors contributed to the sudden fracture in mechanical crankshafts. These factors include poor surface finishing, misalignment, overloading, oil leakage, thrust bearing failure, contaminated oil and misassembling (Table 1). These factors caused havoc to automotive crankshafts in the developing country such as Nigeria as a result of lackadaisical attitude of the users towards installing effective maintenance as prescribed by the manufacturers. Many of the vehicles were overloaded beyond its designed capacity, which sometimes led to misalignment

of crankshaft due to excessive torque pressure, improper main bearing adjustment and excessive rearward crankshaft load pressure due to a malfunctioning front-mounted accessory drive. Oil leakage is caused by improper maintenance of the oiling system or use of bad engine oil. Improper maintenance of engines is very common with the users of cars and buses for commercial purposes.

It was not only mechanically factors that caused crankshaft failure, some human factors also caused it. These factors include welfare of drivers on car maintenance; general conditions of roads have a great impact on the rate of occurrence of crankshaft failure in Nigerian road. Many roads networks in Nigeria are saddled with pot-holes, which are hindrance to improved reliability automobile crankshaft. Unstable weather such as alternation of fog, rain, moist and sun which caused hotness and coldness environment hampered the life of crankshafts greatly. Other factors that caused failure include material and incompetent of maintenance personnel. A lot of fake crankshafts were available in Nigeria and the local maintenance personnel lacked improved training and education.

Meanwhile the results obtained from the failure analyses showed that number of crankshafts failure were decreasing with time for all brands of automobile considered (Table 1), except Japanese cars that were used for commercial purpose. This could be as a result of negligence on the part of the users in installing a proper maintenance scheme or the use of bad oil provided that overloading was not allowed.

Generally, results showed that probability of failures decreased with time for all three categories of vehicles investigated (Table 2 and 3). This showed that the users of the automobile were caring for their vehicles or dynamism and advancement in technology had produced crankshafts which are more rugged than before. Results obtained further showed that private cars have lowest probability of failure in the first three years considered, followed by commercial cars and commercial bushes have the highest failure rate (Fig. 1). In the subsequent years, a change was witnessed, but the changes were very close in the year 2006. Probability results obtained in year 2006 were very small and close to one another, as shown in Fig. 1. This showed that there are improvement in technology, maintenance or training and retraining of personnel involved in maintenance and improvement in educating the users. Figure 2 further explains how reliabilities have increased tremendously for all categories of crankshafts considered and it reached the peak in the

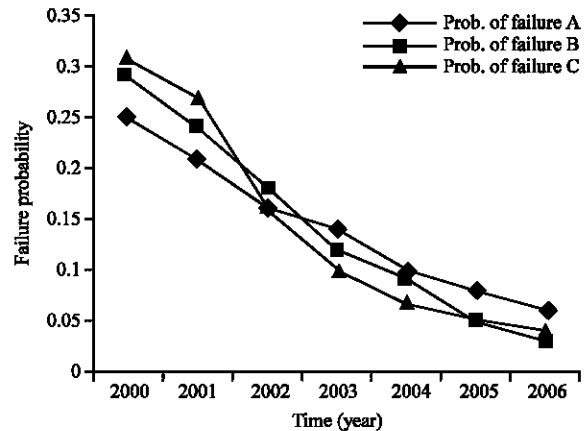


Fig. 1: Failure analysis for cars (A), commercial cars (B) and buses (C) crankshafts

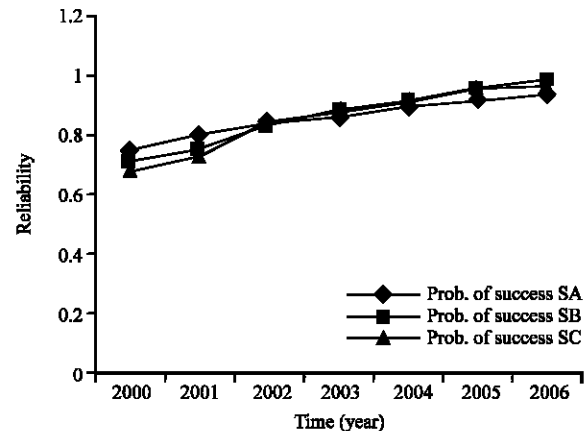


Fig. 2: Reliability analysis for cars (SA), commercial cars (SB) and buses (SC) crankshafts

year 2006. This corresponds to the time least failure rate. This showed there were improvements over the years on automobile crankshaft reliability.

CONCLUSION

Following the views and opinions gotten from the questionnaires administered and oral interview conducted in the identified mechanical workshops, it can be concluded that the failure of crankshaft in automobile came as a result of oil leakages in engines, overloading, misalignment, poor surface finishing, misassembling, poor reconditioning of thrust bearing and adulterated engine oil.

Production crankshafts with locally sourced materials, improvement on the local roads, right mechanical maintenance practice, educating the users

of the vehicles among other measures perhaps could reduce mechanical failure of crankshaft. Furthermore, special team should be set by government to monitor the distribution and sale of engine oil so as to prevent adulteration. On the other hand, appropriate authority should ensure that vehicles are road worthy before allowed to be taken to ply roads in the country. If the above listed steps and recommendations are adhered to, the crankshaft failure could be reduced greatly. For instance, in AM workshop, it was shown that the increase of crankshaft failure was due to lack of proper maintenance and improper mechanical repair. After enlightenment programmes such as training, education and structure upgrading were done, it was shown that crankshaft failure in Nissan and Datsun reduced greatly in the year 2006.

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