Study on the Data analysis of the Camshaft Measuring Systems

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ABSTRACT: The accuracy of the camshaft directly impact the noise, dynamic performance and economy overall performance of automobile engine. This paper will measure the repeatability of the current index value C_g of automotive components testing equipment corresponding analysis and give a set of the integrated measuring instrument data developed by camshaft actual measurement and develop indicators to verify the instrument reproducibility.

I. Introduction

Camshaft is one of five core automobile engine parts, precision camshaft directly affect noise, dynamic performance and economy overall performance of automobile engine.

According to the design requirements of modern instrumentation, measurement error random error should be accounted for the major part. Therefore, in assessing a (kind of) detection device, revealing random error associated with repeatability, reproducibility of these statistical properties are often the focus as the evaluation.

This paper will present a measure of the repeatability index value C_g of automotive components testing equipment corresponding analysis, and given a set using the integrated measuring instrument developed by the camshaft actual measurement data, for the development of indicators to verify the instrument reproducibility.

II. Meaning Measurement Capability Index Values C_g

German auto industry from production reality, the repeatability factor reflects the error detecting device itself a prime location on the proposed measurement capability index C_g assessment method.

During repetitive test, if the sample $n \geq 50$, thus obtaining the actual standard deviation C_g , and further obtain the measurement capability index, in order to make assessment of the equipment, its high precision and reliability, which is why, in August 1999 to develop the guidance document "Measurement system capability", using the measurement capability index C_g of the assessment methods.

$$C_g = \frac{0.2T}{\Delta M}$$

Wherein T is the tolerance measured coefficient distribution and ΔM is in the range of outcomes.

If the measurement errors are normally distributed, then there

$$C_g = \frac{0.2T}{2kgs}$$

Where s is the experimental standard deviation of available well known Bessel obtained from the formula. kgs Represents a confidence probability P of the confidence interval half-width, k is called the confidence factor, and P reflects the implementation of a measurement falls degree intervals may depend, such as when $k = 3$, that is $P = 0.99973$, 99.73%.

That takes 3 k . The standard further made the following specific instructions: The acceptance of a new detection device, if the workpiece tolerance parameters $T \geq 10\mu m$, it is necessary to ensure that $C_g \geq 2$, if necessary assurance $T < 10\mu m$. An additional conditions specified above $C_g \geq 1.33$, it is carrying out repetitive testing process, the number of measurements n must be greater than or equal to 50, if not 50 times, the need to increase the value C_g . When $n = 25$, for the former case, when $C_g \geq 2.2$. As for the periodic verification testing apparatus with the above criteria has been reduced, it is only required to $C_g \geq 1.33$.

Of course, the value C_g of the evaluation method is not limited to the geometry test equipment evaluation, other types of test equipment is also applicable.

It should be recognized that the above assessment indicators are quite demanding. After years of practice have been to relax the use of signs, mainly in August 1999 by the US and European ten car companies jointly issued the "measuring system capabilities" file. At this point the expression C_g from to read:

$$C_g = \frac{0.2T}{4s}$$

It has been calculated and organize get to this condition $C_g \geq 2$ are substituted into the formula:

$$\begin{aligned} 6gs &\leq 10\%gT \\ 4gs &\leq 10\%gT \end{aligned}$$

The meaning of the above two equations expressed very clear: to be assessed on a detection result of the detection device being measured random error distribution width (ie confidence interval size), not more than one tenth tolerances measured. Formula showed confidence probability at this time was 99.37%, while confidence probability formula under the conditions of 95%. This is the true meaning of the measurement capability index C_g , its essence lies in this.

III. The Actual Measurement Results Analysis

According to the above for the definition and analysis, the use of the integrated measuring instrument camshaft journal of the actual parameters of the repeated measurements of 50 times, the resulting based on the measured value and style as shown in Table 2.

According to the standard required for a car company, the nominal value of each parameter needs camshaft and upper and lower limits are shown in Table 1.

Table 1 nominal value and the upper and lower measurement parameters

Parements	Nominal value	Uppe r limit	Lower limit
B journal diameter Left / mm	28.5	28.48	28.459
Right B journal diameter / mm	28.5	28.48	28.459
B journal roundness / mm	0	0.005	0
B journal taper / mm	0	0.008	0
B for AE journal beating / mm	0	0.02	0

Therefore, the camshaft journal diameter tolerance: $T_D = 0.021$

Camshaft journal taper tolerance: $T_C = 0.008$

Camshaft journal roundness tolerance: $T_{RD} = 0.005$

Camshaft journal runout tolerance: $T_A = 0.02$

Table 2 Experimental data in using the integrated measuring instrument developed camshaft measured

measuring frequency	B journal taper / mm	B journal roundness / mm	Right B journal diameter / mm	B journal diameter Left / mm	B for AE journal beating / mm
1	0.0113	0.004	28.4721	28.4651	0.0086
2	0.0112	0.0041	28.472	28.4652	0.0082
3	0.0110	0.0042	28.4722	28.465	0.0078
4	0.0112	0.0041	28.4721	28.4651	0.0088
5	0.0111	0.0041	28.4721	28.4651	0.0088
6	0.0108	0.004	28.4715	28.4657	0.0082
7	0.0109	0.0038	28.4715	28.4656	0.0084
8	0.0109	0.004	28.4717	28.4654	0.0083
9	0.0108	0.004	28.4715	28.4656	0.008
10	0.0111	0.0041	28.472	28.4651	0.0089
11	0.0113	0.0041	28.4720	28.4651	0.0086
12	0.0112	0.0041	28.470	28.4651	0.0084

measuring frequency	B journal taper / mm	B journal roundness / mm	Right B journal diameter / mm	B journal diameter Left / mm	B for AE journal beating / mm
13	0.0110	0.0040	28.4722	28.4650	0.0080
14	0.0112	0.0041	28.4721	28.4651	0.0088
15	0.0111	0.0041	28.4721	28.4651	0.0088
16	0.0108	0.0039	28.4718	28.4659	0.0086
17	0.0109	0.004	28.4719	28.4658	0.0084
18	0.0110	0.004	28.4717	28.4659	0.0085
19	0.0108	0.004	28.4715	28.4656	0.0083
20	0.0111	0.0041	28.472	28.4651	0.0089
21	0.0113	0.004	28.4721	28.4653	0.0086
22	0.0113	0.0041	28.4722	28.4656	0.0082
23	0.0114	0.0042	28.4722	28.465	0.0078
24	0.0112	0.0041	28.4721	28.4651	0.0086
25	0.0111	0.0041	28.4721	28.4651	0.0088
26	0.0108	0.004	28.4715	28.4657	0.0082
27	0.0110	0.0038	28.4715	28.4656	0.0084
28	0.0109	0.004	28.4717	28.4654	0.0083
29	0.0110	0.004	28.4715	28.4656	0.008
30	0.0111	0.0041	28.472	28.4651	0.0089
31	0.0113	0.004	28.4721	28.4651	0.0086
32	0.0110	0.0041	28.472	28.4652	0.0082
33	0.0113	0.0042	28.4722	28.465	0.0078
34	0.0112	0.0041	28.4721	28.4651	0.0088
35	0.0112	0.0041	28.4721	28.4651	0.0086
36	0.0108	0.004	28.4715	28.4657	0.0082
37	0.0110	0.0038	28.4715	28.4656	0.0084
38	0.0109	0.004	28.4717	28.4654	0.0083
39	0.0108	0.004	28.4715	28.4656	0.008
40	0.0111	0.0041	28.472	28.4651	0.0089
41	0.0113	0.004	28.4721	28.4651	0.0086
42	0.0112	0.0041	28.472	28.4652	0.0082
43	0.0113	0.0042	28.4722	28.465	0.0078
44	0.0112	0.0041	28.4721	28.4651	0.0088
45	0.0111	0.0041	28.4721	28.4651	0.0088

measuring frequency	B journal taper / mm	B journal roundness / mm	Right B journal diameter / mm	B journal diameter Left / mm	B for AE journal beating / mm
46	0.0108	0.004	28.4715	28.4657	0.0082
47	0.0109	0.0038	28.4715	28.4656	0.0084
48	0.0109	0.004	28.4717	28.4654	0.0083
49	0.0108	0.004	28.4715	28.4656	0.008
50	0.0111	0.0041	28.472	28.4651	0.0089
C_g	2.2271	2.5801	2.7889	3.7634	2.9976
average value	0.01106	0.00404	28.471846	28.465318	0.008418
Standard deviation	0.0001796	9.689E-05	0.0003765	0.000279	0.0003336

According to the actual measurement data camshaft observed 50 times the diameter of the test results in a journal, roundness, taper, and beating and other measurement parameters, you can see, the dispersion is small, the standard diameter of the test results is less than 0.0003, round the standard deviation of the test results is less than 0.0002, the standard deviation is less than 0.0002 taper test results, standard deviation jitter test results is less than 0.0004, repeated measurement error of each parameter can be controlled within $C_g \geq 2$, has good stability and repeatability, reach the design goal.

IV. Conclusion

This paper introduces the measuring instrument alignment, measurement data were analyzed by the experimental test data in accordance with the measurement capability index C_g assessment repetitive detection system. The results of multiple measurements of the workpiece measuring instrument to verify the accuracy of measuring compliance with the requirements that it has good reliability and stability

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