DESIGN AND CONSTRUCTION OF A STAND FOR CHECKING THE SHAPE DEVIATIONS OF BRAKE DISCS

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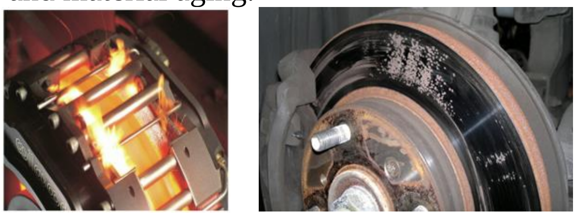
Abstract: *The wear of brake discs and their deformation during operation, due to various causes (sudden cooling due to contact with water, overheating due to frequent operation of the braking mechanism in a short time, etc.) is a common problem in the automotive industry. The purpose of this paper is to find an optimal solution for checking the deviations from the flatness of the brake discs, in the most usual form, by devising a method of making a device that allows measuring, checking and processing data in real time. The design of this device, along with the execution drawings, were created using a 3D program. In the introductory part, a current state of the art for brake unbalance checking devices was made, highlighting existing methods on the market, carried out up to now. An optimal but also functional variant of the device was adopted and organological calculations were carried out together with the technological route of one part of the whole assembly, namely the cone shaft. The description of the aspects regarding the realization of the installation and mentions of maintenance and operation of the stand designed for good operation has been described in detail. Or made calculations regarding the economic aspects by analyzing the production costs of the raw material and that of the manpower. At the end of the paper, the main conclusions regarding the technical condition and efficiency of the device are presented following the requests that appear..*

Keywords: braking, friction, automotive, efficiency, safety

1. Introduction

Beginning in 1949 in England [1], the first brake systems using brake discs and pads were developed. This type of classic braking system was quickly adopted by most car manufacturers and as a result of the much improved braking ability over drum shoes. The appearance of the disc brake led to a reduction in braking time, their use being on a wider scale. Nowadays almost all vehicles are equipped with this type of braking system on both axles. As a working principle, pressing the brake pedal will result in a certain pressure transmitted by means of an incompressible liquid which with the help of a device called an amplifier, the pressure can reach up to 15-16 MPa to the pistons of the system that will push the pads on the surface of the disc and thus braking will be achieved [2].

The main defects found in the classic braking system are: wear of friction pads or shoes, cracks in the discs or drums, deviations from the geometric shape imposed on the working surfaces (deviations from the flatness of the disc or from the cylindricity of the drum) [6]. These faults introduce imbalances during braking, introducing vibrations when the brake pedal is actuated, noticeable at the level of the pedal bridge or in the steering wheel. The causes of this phenomenon are due to the deformation of the discs, on which some geometric deviations of the surface shape have occurred over time [7]. The situations in which these deviations can occur are caused by overloading the braking system, defective ancillary components, respectively blocked caliper guides or by uneven cooling of the disc [3,5]. The main wear that occurs on the brake discs are: corrosive wear, contact wear, abrasive wear, thermal wear represented in fig. 1 and material aging.



(a) (b)

Figure 1: *Thermally overloaded brake discs and the resulting effect*

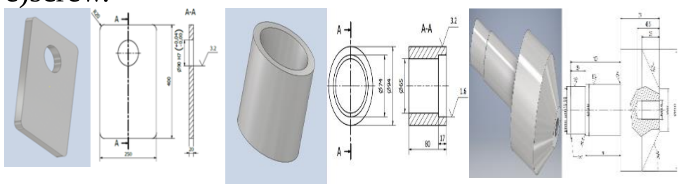
An effective method of checking the deviations from the flatness of the brake discs is the checking of the flatness by means of dial gauges represented in figure 2.

Figure 2: *Checking with the comparator clock*

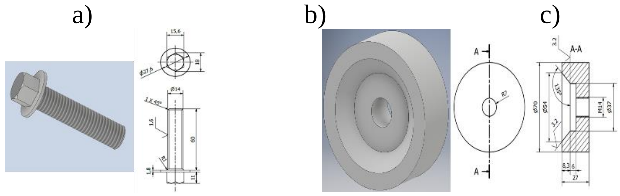
2. Adopting the constructive solution of the stand

One of the main advantages that this stand has is the possibility of performing measurements on both surfaces of the disc at the same time, the fact that it can be used in any field of activity that provides for the verification of these components, especially referring to car services where can check the surface quality of the discs after a certain time and regime of use, or in the case of new discs, before mounting to detect errors that may have occurred due to storage or transport conditions [4].

The component elements of the stand were made in the first phase through 3D modeling with the help of a special program for technical drawing, the execution drawings being represented in figure 3, where they are represented: a) the base plate, b) the fixing support, c) the conical shaft , d)fixing cap and e)screw.



a) b) c)



e) d)

Figure 3: *Drawing in 3D format and execution drawing of the stand components (a,b,c,d,e)*

Table 1 *Mechanical properties and chemical composition of C 45*

	Chemical composition (%)			
SYMBOL	c	min	S	us
C45	0.43-0.48	0.5-0.8	Max 0.37	0.03

Steel brand	Minimum mechanical characteristics					
	Tensile strength daN/mm^2	Elongation at break (%)	Cooking to bursting (%)	Drip limit N/mm^2	Resilience 30/2 daJ/cm^2	The hardness HB
C45	00-840	25-15	-	410	39	207-235

a) Base plate with support bushing and bearing *b) Cone tree* *c)Fixing cover bottom view and top view*

Figure 4: *Stand components*

After carrying out the organological and technological calculations, or choosing the materials for the actual construction and opting for an C45 steel presented in table 1, for the construction of the stand components represented in figure 4.

After assembling them, or carrying out the actual measurements.

This involved marking eight points on both surfaces of the disc at an equal distance from each other, adjusting the clocks from the zero point, then rotating the brake disc so that the feeler could be brought into contact with the surface of the disc over all the points drawn. The precise fixing of the comparator clock was taken into account to avoid the appearance of errors.

3. Results

The procedure involves measuring at eight points on both sides and noting the deviations on the check chart. Having the data on the diagram we can determine the maximum deviations with the data given by the manufacturer

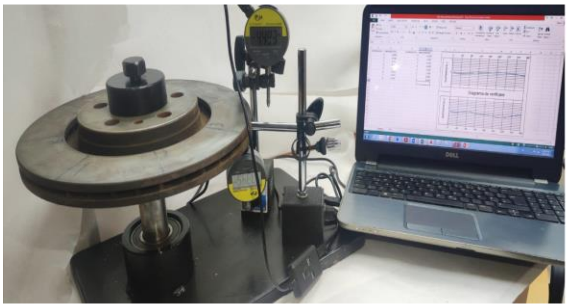


Figure 5: *Device assembly*

The measurements performed are presented in table 2 and based on them, the ovalization values verification diagram represented in figure 6, of the brake disc studied on the two flat faces (surface 1, surface 2).

According to the resulting verification diagram, the deviation found in the case of the brake disc subjected to measurements does not fall within the limits prescribed by the manufacturer according to the published technical documentation which provides for a maximum deviation of 1.5 – 2mm.

Table 2 *The result of the measurements*

Surface 1	Measurements	Surface 2	Measurements
1	-0.898	1	-0.309
2	-0.248	2	1.059
3	0.215	3	-0.183
4	0.791	4	-0.849
5	1.264	5	-1.250
6	0.916	6	1.986
7	0.307	7	0.349
8	-0.965	8	0.828

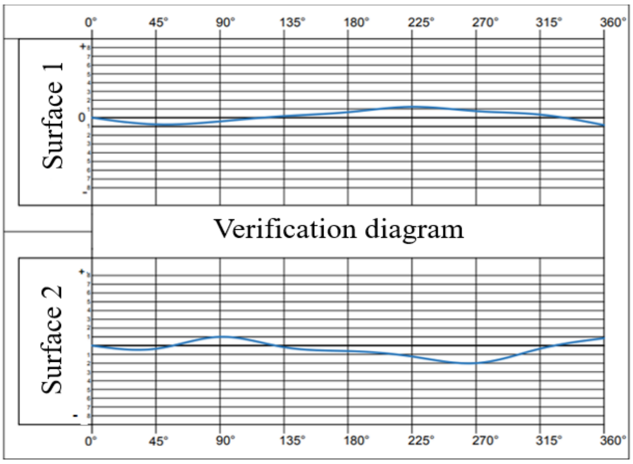


Figure 6: *Ovalization values verification chart*

The biggest deviations were recorded in the case of sections 5 and 6, where a difference of 2.5 mm and 2.9 mm resulted, respectively.

5. Results and conclusions

The design and construction of a stand for checking the deviations from the flatness of the brake discs is to bring to the market a device capable of facilitating the detection of possible brake disc defects, following improper exploitation during driving. Take measurements on a wide range of brake disc sizes. The constructive solution allows the measurement of the two flat surfaces simultaneously.

The reduced dimensions offer the possibility of placing the stand in smaller places within car services as well as in professional training or education units.

Auxiliary, due to its constructive form, this stand is able to perform measurements regarding the deviation from the cylindricity of the brake drums.

The speed of reading and retrieving data is given by digital comparator clocks, data transducers and the calculation system.

For the design of the work, specialized readings from the mechanical engineering and information found in the technical data provided by the brake disc manufacturers were analyzed.

The organological and technological calculations were made with the help of the MathCad program, as well as the execution drawings were made with the specialized design program Inventor 2020 version.

The economic costs for making the assembly are very low in relation to the facilities that this stand offers, significantly reducing the number of operations for such procedures with only the measuring instruments.

The aesthetic aspect is attractive and its use is very easy.

In conclusion, going through all the stages of the work, a high-performance device was created for checking the flatness deviations of a wide range of brake discs at a low price.

Several measurements were conducted using the above presented experimental test rig and the magnitude of the friction torque corresponding to different clamping forces was obtained. The experimental results reveal that the friction torque has a magnitude of 17.75Nm, corresponding to 314N clamping force. The obtained results were used to determine the friction coefficient. According to [8] for urban vehicles the domain values of the friction coefficient can vary between 0.2 and 0.45. Own results show that the coefficient of friction is 0.32. This value validates the experimental test rig and the testing methodology.

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