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BEARING PERCENTAGE OF THE SURFACES

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Abstract. The natural wearing out process as well as the elastic deformations because of the contact compression between parts, diminish a great deal the surface we can rely on. If we analyze only two typical cases: the profile alike to letter m and the profile alike to letter ω, for the bearing percentage for p = 50% in the first case, Tp is much bigger than 50%, and in the second case, it is much smaller than 50%. The "m" profile behaves well when lubricated (does not tear the lubricant film), but it is dangerous for the parts variably stressed (the abysses are primers of cracks favoring the tear when repeatedly compressed and stretched). On the contrary, the "ω" profile is not indicated for lubrication (the points will go through the lubricant film), but it behaves very well when variably stressed.

Keywords: surface, bearing percentage, profile

1. Surfaces and profiles

If we carefully examine the surface of any part that is physically executed, we will find that it shows asperities. We can see the traces of the processing tools or the bends from the drying – cooling – crystallization. The most important sign that the real surface shows deviations from the neatness is the lack of the shiny, mirror aspect. The mat aspect implies light reflection on certain directions because of the microsurfaces with the normals randomly oriented.

The notion of surfaces condition refers to the qualitative deviations related to the aspect that highlight the measure in which the real surface is different from an ideal, smooth surface.

The nominal surface is an ideal surface, suggested in the project by the symbols and representations. It is perfectly neat. The real surface is physiologically defined by the limit that separates the part's material from the environment. It cannot be practically known. What we can highlight with observation, measurement means is the effective surface. By the intersection of the surfaces with plans, profiles are obtained. The orientation of the intersection plans is important in order to highlight certain aspects of the surfaces. According to the names of the surfaces they come from by intersection, the profiles are named: nominal profile, real profile and effective profile [1, 2].

2. Effective profiles

The problem of the surfaces condition had a sinuous evolution determined by the quality aspects that needed to be quantified, attaching the row of natural numbers reported to a correspondence criterion. From the simple biological reaction of asperity for the tactile sense, and the mat aspect, induced by the reflected light beam, to the measurement of certain depths or prominences, lots of notions appeared that lost or changed their meaning.

The classifications in an engineer manner were made after the appearance of the means of profiles processing; profilometetrs, profilographs. In practice, the profilometers imposed with inductive transducers or piezoelectric and interferometers.

The inductive transducers, shown in picture 1 bed with the crosshead 3 on the part's surface, 2. The cross head moves maintaining the contact with the part's surface, due to the suspended oscillating guidance 6. The iron core 5 is solidary with the crosshead and bears two electromagnetic spools L_1 şi L_2. The detector 4 with diamond conic point is solidary with the magnetic yoke 7.

When moving parallel with the mass 1 and approximately "parallel" with the part's surface 2, a monitoring of the part's profile tales place. The magnetic yoke 7 changes the interior of the electromagnet and the inductances of the spools L_1 şi L_2 determining changes of the electromotive force. The two spools are connected in deck and the obtained signal is applied on a condenser with weir sill discharger. An electronic counter registers the discharges, function of time.

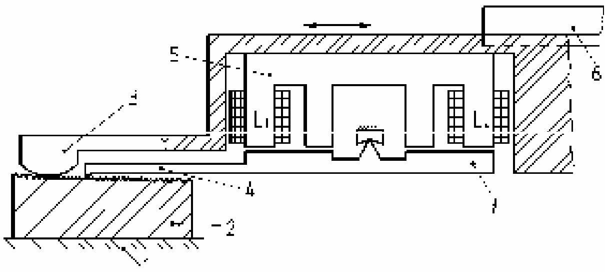

Figure 1. Inductive profilometer

The signal thus obtained and memorized represents at a scale, the numeric integer, function of time, of the effective profile. By an electronic processing in a calculation unit, we obtain the function of the effective profile depths reported to the horizontal movement.

In fact, the effective profile is the graphic of the function *y*(*x*) punctiformly explored and electronically memorized in the data basis. In the optic variant with interference, shown in picture 2, the numeric function of the effective profile is taken from a photoelectric cell the counts the frequency of the interference band.

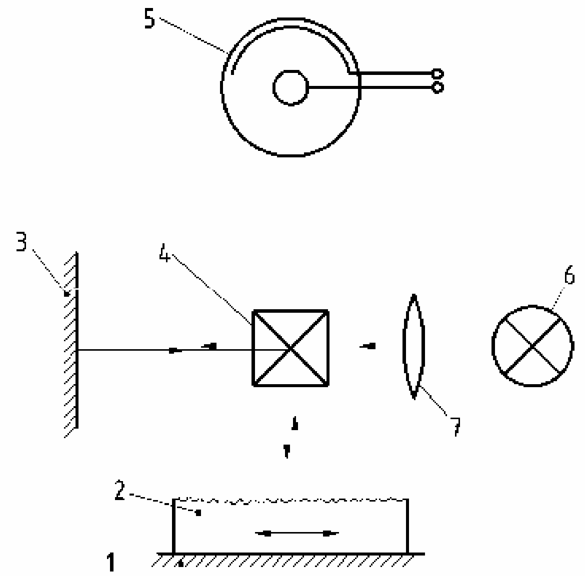

Figure 2. Optic profilometer with interference

The light beam obtained from source 6 and concentrated in the optic system 7, becoming coherent, is separate from the prism with semitransparent sides 4. The beams reflected by part 2, and by the fixed mirror 3 are superposed, arriving on the cathode of the electric photocell 5. The electric signal is electronically taken and processed, thus we obtain the effective profile under a numeric form, *y*(*x*).

As far as the piezoelectric variant is concerned, the mechanic detector transmits the oscillation of the transducer, obtaining in a similar manner the effective profile of the detected part.

We ought to show some remarks. The effective profile is not identical to the real profile. It shows deviations due to the constructive accuracy of the system and the measurement frequency. It is considered the profile is "filtrated". From this point of view, the profiles are of three types:

- total profile where filtration is eliminated as much as possible
- the filtrated profile "goes up" where the measurement frequency is increased and there are non-uniformities called "rugosities"
- the filtrated profile "goes down" where the measurement frequency is low and there appear non-uniformities called "undulations"

In order to be visualized, the profiles will be changed both in amplitude and in longitude. The profilographs dispose of possibilities of choosing the amplification factor and of the paper transport speed where the profile is registered.

The three types of changed and anamorphosized profiles are shown in figure 3.

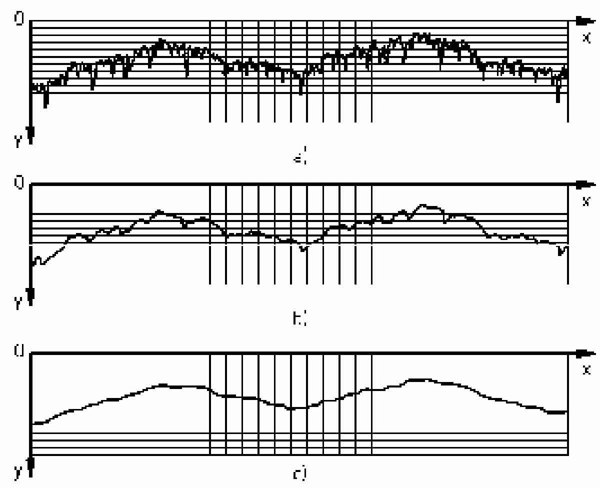

Figure 3. Effective profiles:
a - total profile P; b - filtrated profile "goes up" R;
c - filtrated profile "goes down"

The entire study related to the surfaces' condition has as its basis the effective profile obtained by practical means (with profilometers) and shown as a data basis, the numeric function of the depths *y*(*x*). The effective profile is the graphic of the function *y*(*x*) for each of the filtration variants. The notations of the profiles will be: P – total profile, R – filtrated profile "goes up" and W – the filtrated profile „goes down".

Further, the profile shall limit to the filtrated profile "goes up" shown in figure 3b.

The axles system is oriented with Oy downwards because the ordinates have the significance of depths, because the decoder is above the part. The minimum zones (the ones above) shall be named prominences, and the maximum ones (the ones below) shall be named voids.

3. Profile characteristic parameters

The surfaces' condition is quantitatively appreciated according to the size of the profile characteristic parameters defined by STAS 5730/1 – 91. Further on, the most important characteristic parameters for the filtrated "goes up" profile shall be defined. They are also called rugosity parameters. For the other profiles, the parameters are defined in a similar manner.

3.1. The leveling depth, R_p

Reanalyzing the way of obtaining the effective profile, we find that the position of the coordinates system, the reference one, is randomly chosen by the human operator or even by the apparatus. In order to establish the reference system compared to the effective profile, we defined the leveling depth parameter, R_p. The analytical expression of the R_p is:

$$R_p = \frac{1}{l} \cdot \int_0^l y(x) \cdot dx \ [\mu m] \qquad (1)$$

The geometrical signification is shown in figure 4. The integral represents the surface included between the abscissa Ox and the effective profile.

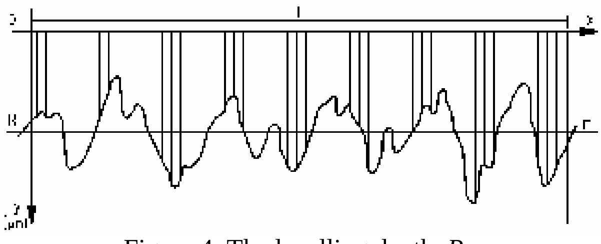

Figure 4. The levelling depth, R_p

The leveling depth is the level of a rectilinear profile (the width of a rectangle of the same surface and length). The „m" line is also called medium line and confirming the position of the coordinates system compared to the effective profile.

3.2. The percentage of the bearing length of the profile, Tp

Sometimes, there are smoothness processes by which the points are eliminated, as it is suggested in figure 5. The natural wear out process as well as the elastic deformations because of the contact compressions between parts, minimizes even more the surface we can rely on, when we superficially calculate it, L x l.

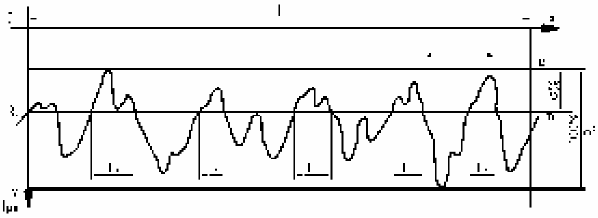

Figure 5. Bearing percentage, Tp

We define the bearing length of the η_p profile as the sum of the segments L_i that is obtained by the intersection of the profile as a parallel to the medium line situated at "p" percentages of the maximum height of the profile, R_y or the distance between the exterior line e and the interior line *i* of the profile that is considered 100%.

The percentage of the bearing line of the profile is the report between the bearing length and the basis length of the profile expressed in percentages.

$$T_p = \frac{100}{l} \cdot \sum_{i=1}^{n} L_i \ [\%] \qquad (2)$$

The positions for which Tp is determined are for $p = 10, 20 \ldots 90$ %.

The bearing percentage provides complex information on the surfaces condition. If we analyze only two typical cases: the profile alike to letter m and the profile alike to letter ω [3, 4, 5]. For the bearing percentage at $p = 50\%$ in the first case Tp is much than bigger 50 %, and in the second case it is much smaller than 50 %. The "m" profile behaves well when lubricated (does not tear the lubricant film), but it is dangerous for the parts variably stressed (the abysses are primers of cracks favoring the tear when repeatedly compressed and stretched). On the contrary, the "ω" profile is not indicated for lubrication (the points will go through the lubricant film), but it behaves very well when variably stressed.

The designers of machines and equipment have at their disposal a considerable number of surface condition parameters by which they can communicate the executants the operating conditions. The constructors of profilometers – profilographs choose only certain profile characteristic parameters that are highlighted by their devices.

4. Symbolization of the surfaces condition

The communication way of the requirements related to the surfaces' condition is limited by the STAS 612-83. On the symbol of the drawing representing a certain surface, we inscribe a sign alike to the radical sign, as in figure 6.

In the places marked with letters, we can inscribe the information wanted by the designer;

- The thickness of the minimum layer that is mandatory removed from the semi-finished product (if necessary).

- There can be three cases: - the material removal is mandatory; - the material removal is forbidden and there is no mention on the initial layer;

- The data related to the profile characteristic parameter. The numeric value of the parameter is mandatory and it means that the effective value cannot be bigger than the one inscribed (an interval can also be provided). For all the parameters besides R_a it is mandatory to specify the symbols of the parameter (R_z, T_p, R_y, …). In certain cases, only the rugosity class can be inscribed (for example de N8);

- The technological procedure by which we obtain the surface: polishing, chroming, HRC hardening;

- The basis length if it different from the normalized value for the parameter at point c;

- The shape and orientation of the traces left from the processing: = parallel or ⊥ perpendicular to the plan of the drawing, X crossed, M random, C circular and R radial.

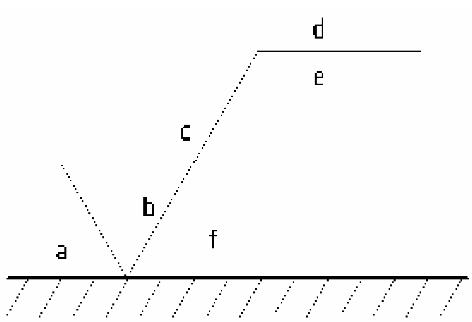

Figure 6. Symbolization of the surfaces condition

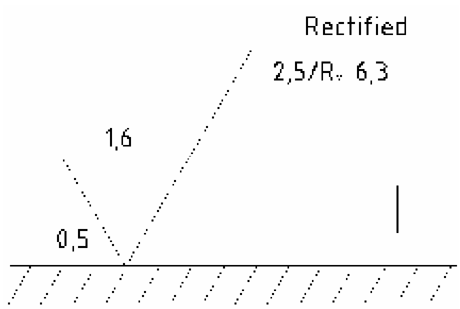

Figure 7. Example of symbolization

For exemplification we provide the symbol in figure 7 with the following significations. The surface is obtained by rectification removing minimum 0.5 mm. The rugosity arithmetical mean R_a is of maximum 1.6 μm and the maximum depth R_y of maximum 6.3 μm. The mandatory basis length is of 2.5 mm. The direction of the traces perpendicular on the plan of the drawing.

The direction of the traces is very important for the sharp edges of the cutting tools. All the razors have the traces perpendicular on the edge. The same is practiced for the modern kitchen knives.

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