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DESIGN TECHNIQUE FOR PRESS FIT JOINT ASSEMBLY

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Abstract: *To ensure the correct and reliable assembly of press fit joints the design technique is presented. How to select different parameters to guarantee easy assembly and the strength of press fit joint was performed.*

Key words: contact type, interference, strength of joint.

1. INTRODUCTION

The press fit is perhaps the most basic of all assembly techniques. It is fast, relatively simple, and economical. But it can also be the most troublesome if incorrectly designed or badly manufactured. In general press fit joint assembly is connected with change of details surface properties and frequently with damage one or several details units.

At assembly on surfaces of assembled details permanent plastic deformation is not supposed as in this case the form of details is damaged, that, in turn, worsens conditions of an assembling. Therefore for optimization of assembly process it is necessary to provide elastic contact of details. We shall define what micro geometrical parameters and physical and mechanical characteristics it is important to take into account at a choice of a material and a kind of processing of assembled details.

2. ANALYSIS

2.1 Contact type

For determination of the contact type [1]:

$$KK = \frac{Sm\theta H}{Ra}; \qquad (1)$$

where Ra- arithmetical mean deviation of surface roughness of assembled details,

Sm – mean spacing of the profile irregularities of assembled details;

H – micro-hardness of the surface layer of assembled details;

$\theta = \frac{1-\mu^2}{E}$ - elastic constant of details surfaces;

(E and μ - modulus of elasticity and Poisson’s ratio respectively). KK numerical value, which is determined using a range of roughness parameters (Ra, Sm) and physical-mechanical characteristics of roughness (H, E, μ- accordingly to each assembled detail), define deformation properties of the assembled details surfaces, i.e. the higher is KK value, the higher is the surface layer elasticity.

The assembled surfaces are elastically deformed if it is subjected to the following condition:

$$KK = \frac{Sm\Theta H}{Ra} > 4 \qquad (2)$$

If KK< 2, the assembled surfaces are plastically deformed.

Sequence of determination of parameters for the assembled details surfaces:

1. Physical-mechanical characteristics (H, E, μ) are selected for the considered surfaces.

2. Elastic contact constant Θ is calculated.
3. The equation (2) is used to calculate the Sm/Ra ratio that ensures an elastic surface contact.
4. Machining type ensuring the required value is selected for the part from the tables (from handbooks of technologist).
5. On the data obtained and applying the parameter boundary values, the Ra parameter value is calculated by equation:

$$Ra = Ra_{min} + \Delta Ra, \qquad (3)$$

where

$$\Delta Ra = \frac{Ra_{max} - Ra_{min}}{(Sm/\ Ra)_{max} - (Sm/\ Ra)_{min}} \bullet \left[\left(\frac{Sm}{Ra} \right)_{max} - \frac{Sm}{Ra} \right];$$

„max”, „min”- indexes of parameter maximum and minimum values;
Sm/Ra – parameter ratio obtained in step 3.
6. The nearest greater value of the parameter is selected up to standard.
7. The selected values of Ra and the type of the surface machining are indicated in the production drawing of the part.

2.2 The strength of press fit joint

When designing components for a press fit, it is necessary that the design provides holding strength adequate to meet the assembly requirements without over- stressing the assembly. This problem contains three factors:

- The choice of correct interference value.
- Part dimensions will change with time due to joint relaxation.
- Joint will fail under long-term loading if the stress exceeds a critical value.

Load resistance in compression joints depends on interference. Too much interference will cause distortion of the inner or outer assembly component. To arrive at a correct fit, such variables as the material, the thickness of details and the thickness of details wall must be carefully considered. Due to the details surface micro cracks formation as the result of press reduced interference and simultaneously specific presser as well. Thereby a joint relaxation can occur [2].

In Fig.1 is shown the calculating scheme of press fit joint.

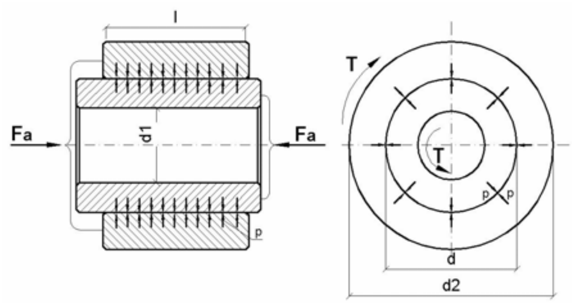

Fig.1.The scheme of press fit joint.

Restriction of press fit strength by axial force [3]:

$$KF_a \leq fp\pi dl, \qquad (4)$$

where p - pressure on the surface contact; K~1.5…2–coefficient of safety; f-coefficient of friction.

Restriction of press fit strength by torque [3]:

$$KT \leq fp\pi d^2 l / 2. \qquad (5)$$

In its turn, p - pressure on the surface contact:

$$p=N/[d(C_1/E_1+ C_2/E_2)], \qquad (6)$$

where N- theoretical interference; C_1 and C_2 - coefficients.

It can be seen that increasing in press fit joint strength can be obtained by the increase of the joint diameter (d), contact pressure (p), length of the press fit joint (l) and friction coefficient (f). The increase of joint length and diameter causes the increase of the weight of the unit and a whole construction that is not economical way for the increase of the press fit joint strength.

The contact pressure can be increased by performing larger joint interference or by increased stiffness of parts in a joint but limited by material yield strength point of parts [4].

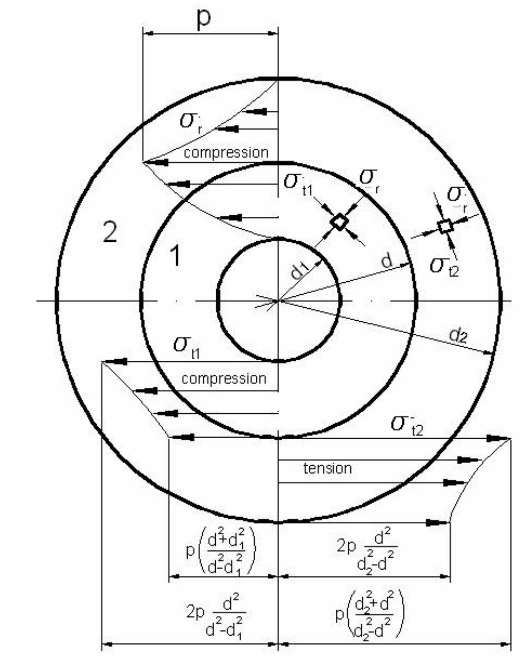

Fig.2. The scheme of stress distribution.

Fig.2 shows the equations and the diagrams of stresses, where: σ_r- radial stress; σ_{t1} and σ_{t2} – compressive stress and tensile stress in tangential direction.

The contact pressure (p) is determined by formula (6) by maximal interference

$$N=N_{max}-u, \qquad (7)$$
$$u= 1{,}2\ (R_{z1}+R_{z2}),$$

where u- adjustment of cutting and surface roughness' smoothing ; R_{z1}, R_{z2}- mean of surface asperity heights.

The given equations are correct in limit of elastic deformation. The restriction by which haven't be plastic deformation in details is

$$\sigma_{eq}=\sigma_1-\sigma_3\le\sigma_T\,, \qquad (8)$$

where σ_1- maximal stress, σ_3- minimal normal stress, σ_T- material yield point.

It is not difficult to understand that less equivalent stress will be in inner surfaces of both details, hereto, for detail -2: $\sigma_1=\sigma_{t2}$; $\sigma_3= -\sigma_r= -p$;

$$\sigma_{eq}=p\left(\frac{d_2^2+d^2}{d_2^2-d^2}\right)-(-p)=p\frac{2d_2^2}{d_2^2-d^2}\le\sigma_{t2}$$

or $p\le\sigma_{t2}(d_2^2-d^2)/(2d_2^2)$,
(9)

and for inner detail (1):

$$p\le\sigma_{t1}(d^2-d_1^2)/(2d^2). \qquad (10)$$

3. CONCLUSION

To guarantee easy assembly and the strength of press fit joint it is necessary to identify contact surfaces of assembled parts, which include: a) determination of the contact type to receive appropriate parameters of surfaces; b) determination of the dimensions and the interference value.

As it was already mentioned above, in assembly process change of a micro relief is not supposed during the contact of details and besides the force of friction arising between contacting surfaces, should be minimal-hence at interaction of roughness of one surface with another their elastic deformation should be provided.

So, we shall define what micro geometrical parameters and physical and mechanical characteristics it is necessary to take into account at a choice of a material and a kind of processing of assembled details.

4. REFERENCES

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