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COMPUTER DESIGN OF FINISH PROCESSING OF NON-RIGID DETAILS

Educed features of finish treatment of non-rigid details of air-space, machine-building and other industries. Offer general methodology of computer design of processing polishing of non-rigid details. An algorithm over of creation of working model of the system "workpart - grain - copula" and results of calculation of proposed thermomechanical model are brought.

Requirements to exactness of sizes and quality of superficial layer of various details increase constantly, together with it an all greater value is acquired by the finish operations of treatment, such as grinding, tweaking, polishing and other. Unlike the operations of cutting by a bladed instrument, treatment an abrasive instrument is small investigational, by principal reason what stochastic character of process is. At abrasive treatment on the parameters of treatment considerable character influence, not only cutting modes but also choice of instrument and it description. Thus, for example, sizes, form and location of abrasive grains in a grinding wheel, and accordingly and cutting corners, have probabilistic character. In connection with what microcutting forces constantly change by value and by direction of action that especially negatively affects quality of treatment of non-rigid details. Thus, research of process of abrasive, finish treatment of non-rigid details is an actual task.

In air-space, machine-building and other industries non-rigid details are widely widespread such, as crankshaft and camshaft, compressor and turbine shoulder-blades, thecal forms, needle-shaped details and other. In work [1] investigational traditional processing schemes gas-turbine shoulder-blades and the new method processing of workers and base surfaces of shoulder-blade offers by an abrasive ribbon by means of robot with the system numerical control PM-01. A module 3D design of process of creation and removal of assumption is in-process conducted, the numeral values of cutting forces and their change are however certain in the process of treatment, a degree and form of deformations of shoulder-blade are not investigational in the process of polishing of internal and external profiles of peer and transitional edges.

In a number of works from the computer design of grinding process [2, 3] basic attention is spared to the structure and properties of grinding wheel, as the least proof link. As a result of researches methodologies of choice are offered as copulas, concentrations et cetera, from the terms of optimal firmness and turning of working surface of instrument. At a traditional mathematical and computer design the weak element of the working system is tools that tests most deformations and determines exactness of treatment, however at polishing of non-rigid details maximal size of deformations of it is observed exactly in a detail. Insufficient inflexibility of detail predetermines the necessity of application of additional equipment and specific charts of treatment, and also lays on a limit on the modes of cutting that diminishes the productivity usually. As known, complete deformation of purveyance during treatment for time unit is determined:

$$\varepsilon = \varepsilon_{elastic} + \varepsilon_{plastic} + \varepsilon_{creep},$$

where $\varepsilon_{elastic}$ – elastic component; $\varepsilon_{plastic}$ – plastic component; ε_{creep} – creep deformation.

The necessary condition of calculation is the use of terms of equilibrium, terms of compatibility of deformations, kinematics dependences between deformations and moving. At the computer design of treatment cutting, the process of destruction is examined as cyclic. A criterion for the removal of shaving accept by means of method of in good time certain surface

$$f = \sqrt{\left(\frac{\sigma_n}{\sigma_f}\right)^2 + \left(\frac{\tau}{\tau_f}\right)^2}, \quad \sigma_n = \max(\sigma_2, 0).$$

Destruction arises up, at $f \geq 1$, in this case the resiliency of element equals a zero.

In basis of realization of method of complete elements in such software products, as ANSYS, LS-Dyna, Abaqus and other nonlinear mechanics of the tensely-deformed body, that is base on row of fundamental laws and equalizations, is fixed:

1. Law of maintenance of mass: $\rho \cdot J = \rho_0$, where $J = \det(F)$ – Jacobian, or relative volume presently to time; ρ, ρ_0 – accordingly actual and initial to the closeness of material; $F = \frac{\partial x_i}{\partial X_j}$ – gradient of motion.

2. A law of conservation of energy is on condition of absence of thermal sources: $\rho_0 \cdot \dot{\omega}^{int} = \dot{F} \cdot \sigma$, where $\dot{F}$ – speed of gradient of motion; $\dot{\omega}^{int}$ – speed of change of internal energy(internal power).

3. Law of maintenance of amount of motion: $\rho \cdot \ddot{u}_i = \rho \cdot f_i + \sigma_{ij,j}$, where f_i – closeness of by volume forces; $\sigma_{ij,j}$ – derivatives of part of component of tensor of tensions of Cauchies σ_{ij}.

4. Equalization of equilibrium $f = f_{load} + f_{contact} - I$, where f_{load} – a volume is erected and external, that operate on a body; $f_{contact}$ – erected forces and pin borders of body; I – internal forces.

5. Law of heat-conducting of Fourier $\rho \cdot C \cdot \frac{\partial T}{\partial \tau} = \frac{\partial}{\partial x_i}\left(\frac{\partial T}{\partial x_j}\right) + Q$, where $Q = \eta \cdot \sigma_{ij} \cdot \dot{\varepsilon}_{ij}$ – power of by volume and thermal sources.

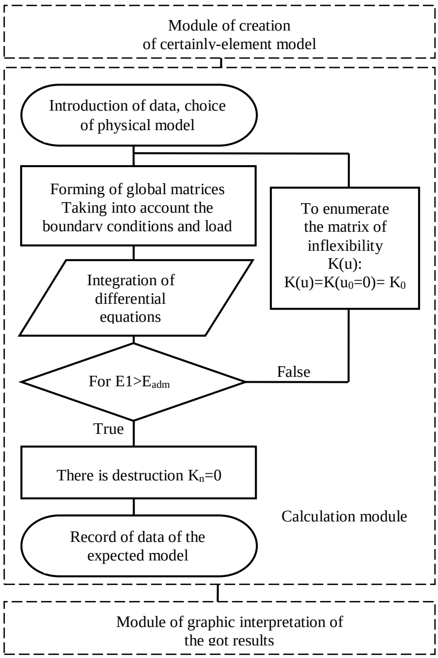
6. Maximum terms: $\sigma_{ij} \cdot n_i = P$ – forces are on the border of body, $u = U$ – moving is to the border of body, $(\sigma^+ + \sigma^-) \cdot n = 0$ – forces are on a pin border, at

$u^+ = u^-$, $\lambda \cdot \frac{\partial T}{\partial x_i} \cdot n_i = q_s, T = T_s$ – thermal streams, or set temperatures on a border accordingly, where $q_s = \tau_n \cdot \dot{u}$. Together a thermal stream must be up-diffused between shaving, purveyance and instrument.

7. hypothesis of destruction, and law of friction $\tau = -\mu|\sigma_n|\tau_{max} \frac{\Delta \mathbf{v}}{\|\Delta \mathbf{v}\|}$.

Decisions carry out on the basis of continued model in approaches of Lagrang and Euler. General methodology of construction of complete-element model for the tasks of creation is driven to work [4]. With the aim of construction of three-dimensional model of the cutting system "workpart - grain - copula" it is expedient to use the system SolidWorks, the task of parameters of materials of tool and detail comes true in LSPrePost.

A block is a chart of realization of programmatic calculation on slave on scheme 1.

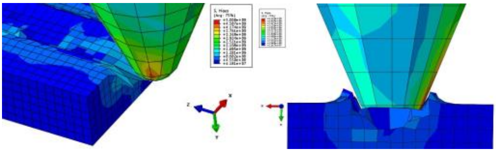


Scheme 1 – Flow-chart of computer design of finish processing

Will undertake a thermomechanical study of process of grinding of needle-shaped detail one abrasive grain. The resiliency of detail is determined by it geometry and method of fixing. The rightness of choice and construction of model of instrument influences on adequacy of design of process of finish treatment. In-process [3] but other similar, it is suggested to design abrasive grains in form rectangular parallelepiped, cone, spheroid, ellipsoid, octahedron and other In this case design of sharpening of needle-shaped surface abrasive tool with the middle size of grains of 160 micrometer, in quality of geometrical model of grain accept a cone with the radius of rounding at a top.

With the aim of the most complete reflection of terms of fixing of grain in a copula and grant to grain of necessary orientation will model a copula in a kind to the parallelepiped, choose properties of material of that most near to properties of ceramic copula. At creation of net of complete elements on the surface of instrument accept the size of elements of grain less than sizes of elements of copula, with the aim of reduction of machine time to the calculation of the system, and taking into account insignificant losses of exactness on a copula. Accept the sizes of net of detail variables, thus the size of her increases at remote from a zone treatments.

The results of calculation are brought around to scheme 2.



Scheme 2 – Results of calculation are on temperature and pin indexes

Conclusion

The features of finish processing of non-rigid details of air-space, machine-building and other industries are in-process analysed. Offer general methodology of computer design of treatment grinding of non-rigid details. An algorithm over of creation of working model of the system "workpart - grain - copula" and results of calculation of an offer thermo-mechanical model are brought.

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