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CAPTOR FOR MEASURING THE DYNAMIC COMPONENTS OF THE CUTTING FORCE AT CERAMIC MATERIALS GRINDING

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1. INTRODUCTION

Corresponding to the schematic in fig.1, in order to ensure an adequate measurement of the cutting force components, the force captor is mounted within the experimental stand on the driving plate of the workpiece mounting device situated on the front side to the right of the tool bearer.

This accomplishes two functionalities simultaneously:
- measurement of the cutting force components during internal grinding;
- fastening of the workpiece into the measuring device.

The device is manufactured entirely of duralumin which ensures:
- low specific weight, and thus a sensitivity increase of the transducer during processing;
- mechanical resistance and increased rigidity, comparable to those provided by steel;
- the possibility for thermal effect compensation during processing;
- reduced action of external disturbing factors such as mechanical vibrations;
- reduction of the dynamic effect of transient regimes at power up and shutdown, inversion of the tool direction, entry or exit of the tool in or out of the work material;
- protection against undesirable effect of external factors such as chips, humidity or dust;
- the mounting solution for the transducer elastic elements allows in both cases a compact and rigid device, with possibility to continuously adjust the mobile elements subject to external strains;
- the connection cables are designed and distributed within the captor to ensure correct shielding of all electrical signals received from transducers and to avoid parasite signals with higher frequency and amplitude than those of measured signals.

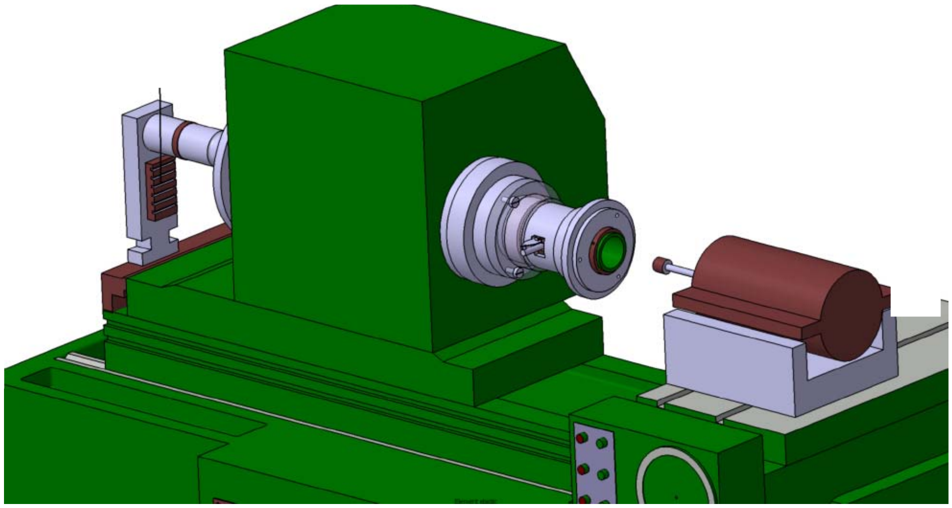


Fig. 1

The captor represents a complex electromechanical device, which through a series of successive transformations converts the variation of the mechanical input into electrical output.

The structure and components of the captor are determined by the specific processing operation, measured quantities, its position within the measurement chain, as well as the relations established between mechanical components, e.g. between elastic elements with their associated mechanical devices and electrical components (transducers, connections, embedded electronic devices, signal processing unit). In order to obtain a captor with good performance in all situations, these aspects need to be taken into consideration as early as the design phase (fig. 2).

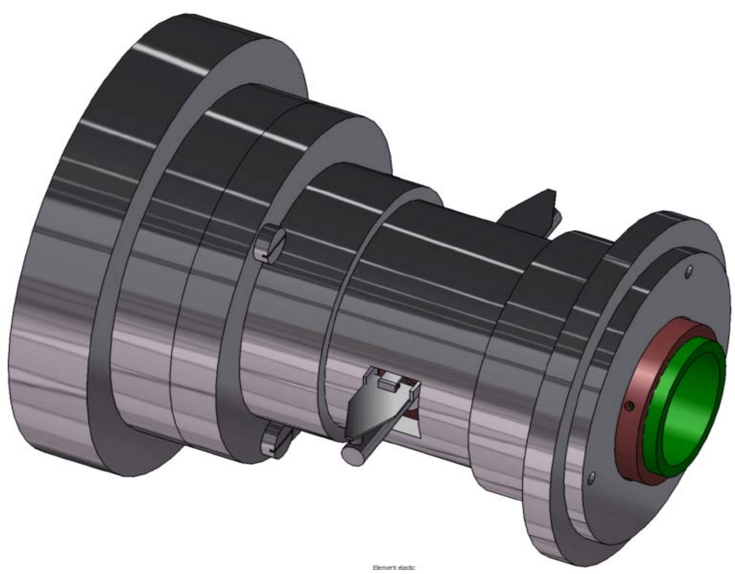
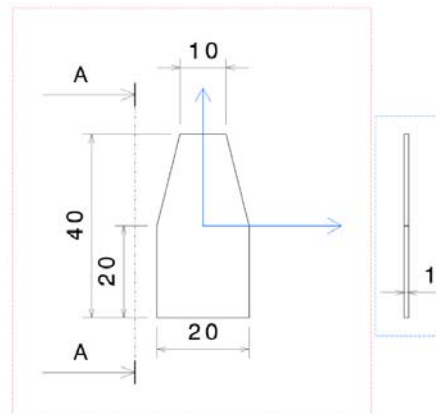


Fig. 2

1.1. ELASTIC ELEMENT

Corresponding to fig. 2 for both measurement situations, the elastic element is represented as an equal resistance element which must meet the following conditions:

- to allow mounting of the resistive electrical transducers according to the schematic which ensures the best measurement accuracy;
- to be manufactured from a material whose elasticity coefficient is as close as possible to the TER linear deformability domain;
- to provide thermal effect compensation;
- to present a low hysterezis;



Observation: The material used was steel arc, whose properties meet the imposed requirements

2. FINITE ELEMENT ANALYSIS OF THE ELASTIC ELEMENT

2.1 STATIC CASE

It is considered the lamella within A3 surface loaded with a force concentrated at the contact with the sensor which bends the lamella (fig. 3).

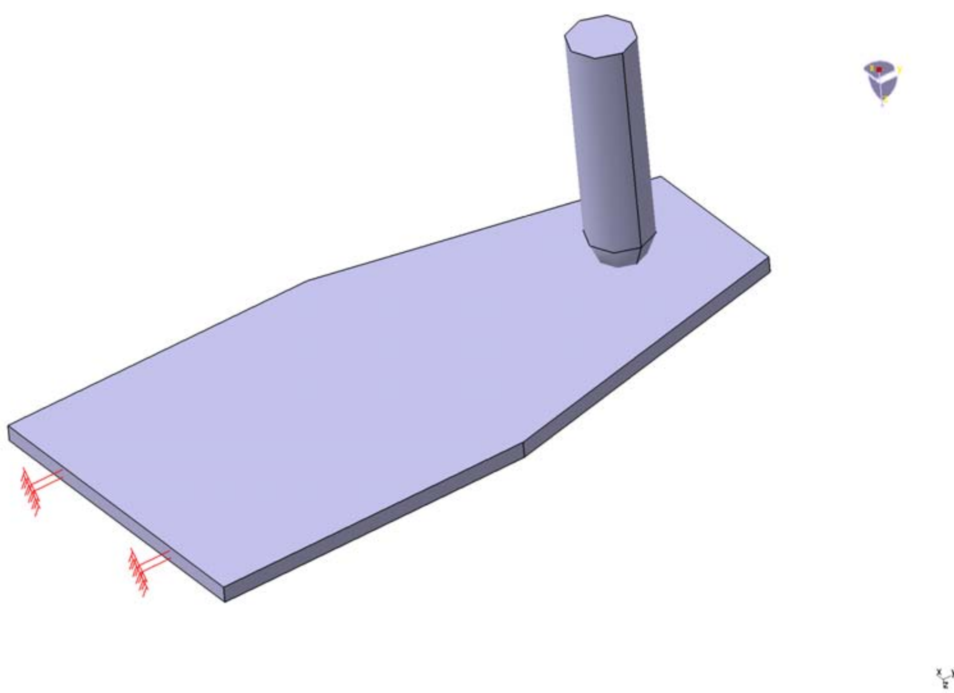
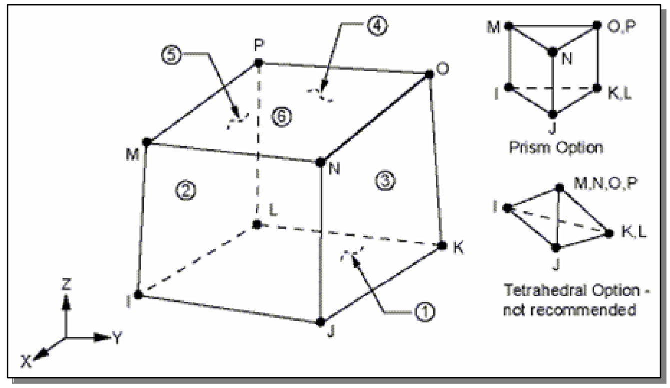


Fig. 3

2.2 DISCRETIZATION

It is employed a very fine network of "type Solid185" elements, which are elements used for 3D modeling of solid structures. The element is defined using 8 nodes with 3 degrees of freedom for each node and nodal translations in x, y and z nodal directions.

The geometry of the "Solid185" element is presented in the figure; the implicit coordinate system of the element is parallel with the global coordinate system.



2.3. SOLUTION

In this phase it is defined the static type of the analysis and are applied constrains and forces that load the model. In the sensor contact area it is applied a concentrated force of 5N.

2.4 POST-PROCESSING

In this phase the results are analyzed.

Since the elastic element's shape is close to that of a equal resistance solid, the equivalent tensions are uniformly distributes an present a small variation (fig. 4).

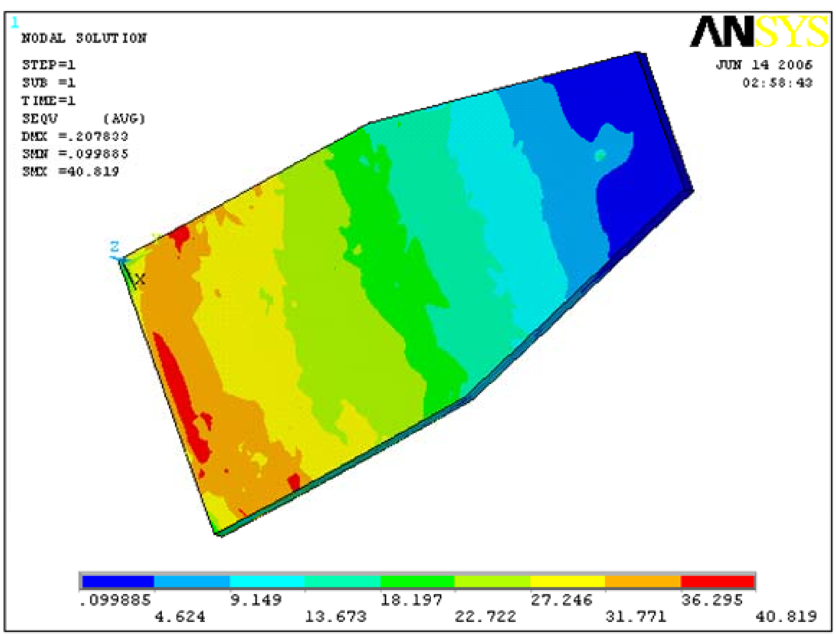


Fig. 4

The nodal displacement have the distribution from fig. 5, where the loose end has the largest arrow.

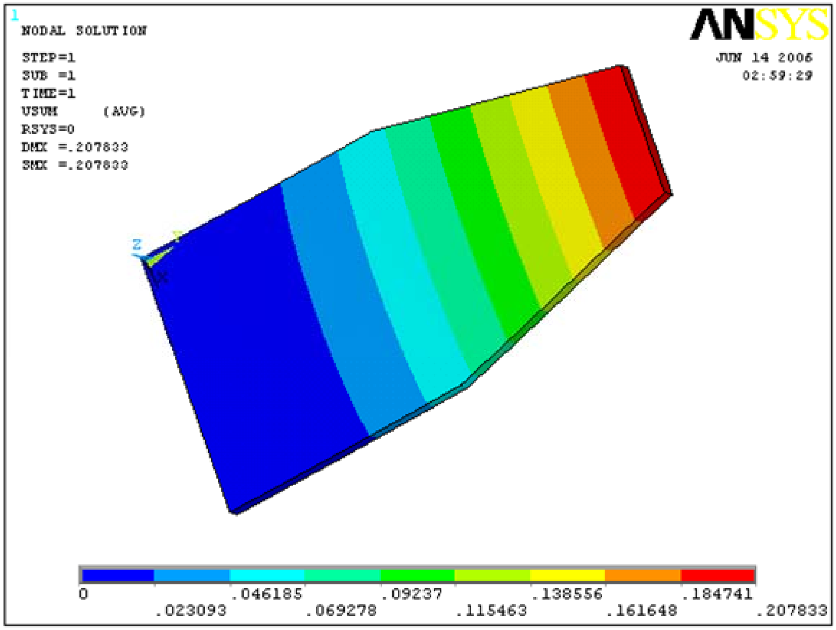


Fig. 5

3. CONCLUSIONS

In this case we have:

- concrete possibilities for manufacturing the force measuring captor such that to ensure most precise measurement conditions, without the need of intermediate elements that determine introduction of measurement constants with a high approximation degree;
- the need of achieving minimal structures of the measurement chain, such that to avoid eventual errors due to improper functioning of the devices;
- an adequate length of the measurement chain, with possibilities for extension or further adaptation within a measurement and control process.
- optimization of the elastic element dimensions performed using finite element analysis.

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