Annals of DAAAM for 2010 & Proceedings of the 21st International DAAAM Symposium, Volume 21, No. 1, ISSN 1726-9679
ISBN 978-3-901509-73-5, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2010
Make Harmony Between Technology and Nature, and Your Mind will Fly Free as a Bird
DAAAM Symposium

ASPECTS OF DYNAMIC ANALYSIS FOR FD320A MILLING MACHINE

DUTA, A[lina]; OZYILMAZ, E[mre]; RAICU, L[ucian]; SASS, L[udmila] & STANESCU, G[elica]

Abstract: *This paper proposes a method for the determination of the displacement starting from some experimental researches and using an analysis with finite elements. Before this, an important problem is to achieve a model with finite elements that must be the best approximation of the tool-machine structure. This is done through a dynamic analysis with variable forces; being well known that the vibrations appeared may cause large displacements and severe stresses in the concrete situations. The analysis proves that the displacements are within admissible limits and have no major influences on the quality of the processing surfaces.*
Key words: *shell type elements, dynamic analysis, holder tool-post shaft, gears*

1. RESEARCH PREMISES

Determining experimentally the precision of the kinematics rolling chain has represented a problem of less interest for researchers so far. However, knowing the size of the cutting forces that appear during the milling with the hobbing-gear cutter is a matter of great interest, both for design engineers, and for the builders of such machines. The size of these resistant forces is important in dimensioning first the elements of the kinematic chains of the machine (the main kinematic chain, the rolling chain, the advance chain) and secondly the carrying away engine.

The time variation of these forces is necessary to determine the dynamical stability of the machine – tools, and also the influence of this variation upon the execution precision of the gear wheels. All of these lead to the necessity of knowing the size and the form of the splintering efforts arising when processing by friction the gear wheels. The moments of the inertial forces appear for many reasons, of which the most important are: the lack of uniformity in the steps of the gear wheels teeth, the knocking of the rolling circles of the gear wheels, the lack of co-axial of the nail bearings, and the unbalanced masses. We slightly simplified the FEM analysis, because we considered that the cutting forces appear in this temporary point of contact between those two parts involved in the cutting process.

2. DATA ACQUISITION SYSTEM FOR TORTIONAL MOMENTS ON MILLING MACHINE

The measurement of the splintering forces was realised by means of dynamical tensometry, using a dynamic tensometer arbor with Vishay marks, with a special construction. Signals were taken using a collector with segments with silver contacts transmitted through a tensiometrical bridge to the data acquisition system (the hard – boards for data acquisition and the software application for data acquisition and primary processing), entirely produced by the Vishay company, USA. The the time measurement of the acquisition system is of 10 seconds (100,000 measurements/sec), and we can speak of a real time data acquisition (figure 1).

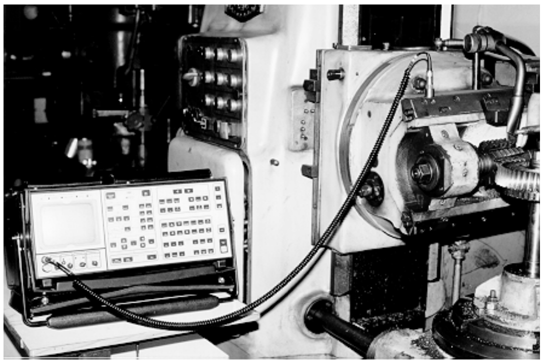

Fig.1. Measurement system (overview)

2.1 Methodology of primary processing and interpreting of experimental results

We processed the straight gear teeth from only one movement/passing over the entire height of the tooth, the program of the measurements for determining the torsion moments due to the splintering forces being shown in table 1. It can be noticed that the data acquisition program takes as separate events the measurement in itself, namely the inactive duration between measurements, so that the events having odd number correspond to the measurements, and the events with an even number correspond to the periods between the measurements.

Modulus (mm)	Number of rotations n (rot/min)	Ap/Bp	Advance speed w (mm/min)	Measurement Event	Mt_{max} (Nm)
2	118	27/31	5.6	3	49.64375
2,5	95	24/34	4	19	95.07875
2,5	95	24/34	8	13	111.5887
2,5	150	31/27	4	27	60.87
2,5	150	31/27	8	31	80.8275
3	118	27/31	2.8	43	42.33125
3	118	27/31	11.2	37	76.18
3,5	95	24/34	4	49	52.95875
3,5	95	24/34	8	53	80.46825
3,5	150	31/27	4	61	67.47
2	118	27/31	void functioning	7	31.47625

Tab.1. The program of the measurements and the torsion moments experimental obtained

2.2 Experimental results: values of the bending moments

The primary processing of the results of the measurements is done on computer by using the very data acquisition program that also supplies the Fourier transform of the measurement signal. In figure 2, we present the gathered signal and the Fourier transform for the measurement event no. 3.

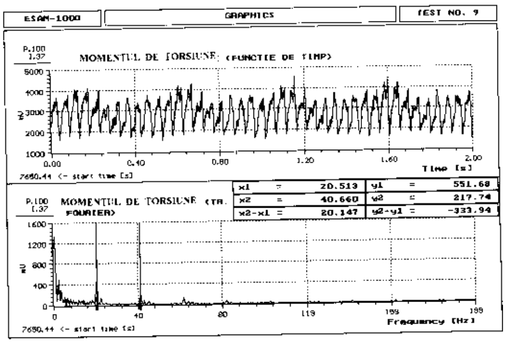

Fig.2. Acquisition and primary data processing of an event (m=2mm, n=118rot/min; w=5,6 mm/min)

From the interpretation of the resulting diagrams, after registering the splintering efforts Mt (Nm), on basis of processing the diagrams, the torsion moments under their harmonic form have the values given under a synthetic form in table 2.

Modulus (mm)	Measurement Event	Ap/Bp	Value at the Torsion Moment Mt (Nm)
2	3	27/31	21.4092+7.5367 sin3.9056t+0.6308sin7.928t
2,5	19	24/34	30.4682+20.447 sin0.2915t+ 7.4364sin2.623t
2,5	13	24/34	31.5997+19.230sin0.2915t+ 6.5643sin2.623t
2,5	27	31/27	18.8543+11.863sin0.048t+ 4.3836sin4.255t
2,5	31	31/27	29.2643+15.077sin0.048t+ 6.7767sin4.255t
3	43	27/31	27.4049+2.2422sin3.2647t+ 0.011sin31.656t
3	37	27/31	46.2815+8.9642sin3.2647t+ 3.5382sin6.471t
3,5	49	24/34	18.2074+9.2239sin0.2331t+ 4.9553sin2.623t
3,5	53	24/34	36.3543+13.7468sin0.2331t+ 8.3723sin2.623t
3,5	61	31/27	30.3306+11.9658sin0.048t+ 4.6219sin4.314t
2	7	27/31	18.2797+10.3187sin0.2915t+ 0.0108sin31.65t

Tab. 2.The program of the measurements and the torsion moments obtained experimentally

3. STRUCTURAL MODEL OF MILLING TOOL-MACHINE PROPOSAL FOR F.E.M. ANALYZE

The geometry defines it is realized by generating a network of points, curves, surfaces and regions. The nodes and finite elements network is realized by manual generate proceedings, automaton and semiautomatic for the finite elements applied to the geometrical elements of surface and regions type. At the end of this generating process there were obtained more than 4872 elements and 5230 node. The geometric characteristics refer to the thickness of every kind of the plates, which are used for modelling the structure of the milling machine body. It was adopted for every kind of plates groups of elements, type of elements, and thickness, associated with every real constant. For the analysis of the structure it was used the COSMOS/M program package. It was done a static analysis, followed by a dynamic analysis of the milling machine structure.

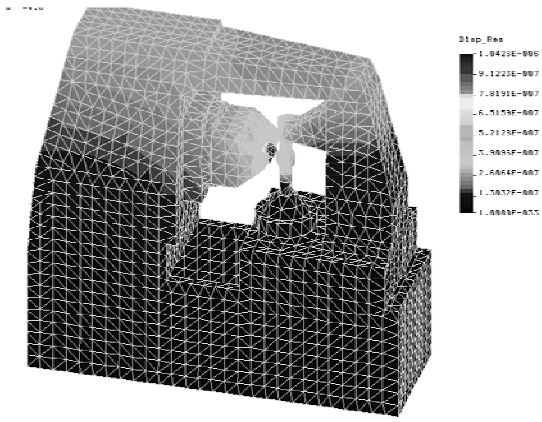

Fig.2. The model used for the static and dynamic analysis.

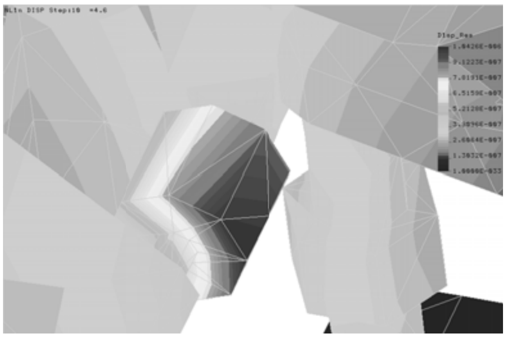

Fig.3. A detail for the contact area (with deformed structure)

4. CONCLUSION

Until now, the structural calculus with the method on the finite element has been very rarely used for complex structures such as the tool-machines, making determinations at the subassembly level. The attempts presented represent, undoubtedly, a step forward. The advantages are: the facility in accomplishing the model, within certain approximate limits; a relatively reduced number of knots and elements, the short duration of the static analysis, but long enough for the dynamic analysis, with a relatively medium number of analysis intervals. Despite all these, the results we obtained through dynamic analysis with F.E.M. are very close, regarding the duration of our study, to those obtained experimentally with the help of a vibration analyzer.

The results obtained due to the conclusion that the model is correctly made and, also, can open a new way for optimizing this kind of tool-machines structure.

5. REFERENCES

Constantinescu, I N., Stefanescu, D. M.; Sandu, Al. M. – Masurarea marimilor mecanice cu ajutorul tensometriei, Editura Tehnica, Bucuresti, 1989;

Dobre, D.- Cosmos/M, Designer II, CAD, Report Bucuresti, Febr. 1996;

Minciu, C.- Contributii privind precizia mecanismului fictiv din lantul cinematic de rulare al masinilor –unelte; IFTOM-SYROM; Bucuresti, 1977;

Taru, E; Teodorescu, M- On the dependence of torque moment and cutting force on the work material hardness during gears hobbing, Galati, Fascicula V, anul V, 1987;

***COSMOS/M Finite Element Analysis System, FEA User Guide, Structural Reserch & Analysis Corp.,2004