DYNAMIC ANALYSIS OF MILLING MACHINE STRUCTURE

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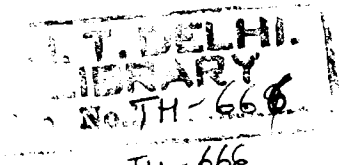

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C E R T I F I C A T E

This is to certify that the thesis entitled "Dynamic Analysis of Milling Machine Structure" being submitted by Mr.J.N.Dube to the Indian Institute of Technology, Delhi, for the award of Degree of Doctor of Philosophy in Mechanical Engineering is a record of bonafide research work carried out by him. He has worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis.

The results contained in this thesis have not been submitted in part or in full to any other University or Institute for award of any degree or diploma.

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J. N. Dube

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A B S T R A C T

Higher accuracy demanded from modern machine tools is adversely affected by deformation occurring by static and dynamic forces during cutting operation. While static deformations have attracted the attention of investigators, dynamic aspect has not been sufficiently studied. This thesis reports a study on dynamic characteristics of a milling machine structure. Complete milling machine structure has been analysed both numerically and experimentally. Utilization of the results of present study can lead to higher dynamic rigidity of milling machine structure.

Matrix method has been chosen for the numerical analysis of the structure. The resulting eigen value problem has been solved by Jacobi, QR and Bathe's methods. Using the actual cross-sectional properties of a milling machine structure, these three methods have been compared. Bathe's method has been found to require least computation storage.

An one-fourth scaled perspex model of the actual milling machine has been analysed for lowest twelve frequencies and mode shapes by Bathe's method. These compare favourably with the experimental values obtained on the model leading to the conclusion that the analytical method used is highly reliable.

To study the effect of ribbing three additional perspex models have been constructed with solid elements replaced partially or fully by ribbed hollow sections. The close agreement of analytical and experimental results of these models further leads to added confidence in the method. The effect of d/b (Depth/Breadth) ratio of column in milling machine structure has also been studied analytically.

The kind of comparison between analytical and experimental results reported above has also been done on the actual milling machine. The natural frequencies and mode shapes as determined from the model of the milling machine structure scaled upto the actual machine using the similarity analysis are compared with the natural frequencies and mode shapes of the actual machine experimentally as well as analytically.

It is concluded that the Bathe's method for solution of eigen value problem can be used effectively for large machine tool structures. From the analysis of the scaled models, it has been observed that the ribbing of cross-arm and saddle base increases the natural frequencies as well as results in weight reduction of structure; mode shapes however retain the same pattern. Increase in d/b (Depth/Breadth) ratio of column results in increase in natural frequencies

also. From the above it is concluded that dynamic rigidity of milling machine structure may be increased either by ribbing cross-arm and saddle base or by increasing d/b ratio of the column.

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