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Appendix A

Finite element model updating

In section 2.5.2 the shunted piezoelectric absorber was implemented on a FEM of an aluminium cantilevered beam, in order to verify the mathematical model of shunted piezoelectric absorber. An attempt to model the tool holder of the lathe with finite elements is documented in section 3.3.2. In both cases the structures were modelled with Bernoulli-Euler beam-elements and updated to match experimental results with an optimisation algorithm.

The optimisation algorithm minimised the difference between the EMA and FEM natural frequencies. The matching modes were selected via a MAC test.

A.1 FEM updating results of the cantilevered beam

The finite element model of the cantilevered beam was updated with and without the actuator since, the addition of the actuator had a large influence on the structural modes. The modulus, density, height and width of the beam elements were as variable parameters in the model updating process. A stiffness coefficient was added to the model as a variable parameter, in order to simulate the static influence of the actuator.

A.1.1 FEM updating results without the actuator

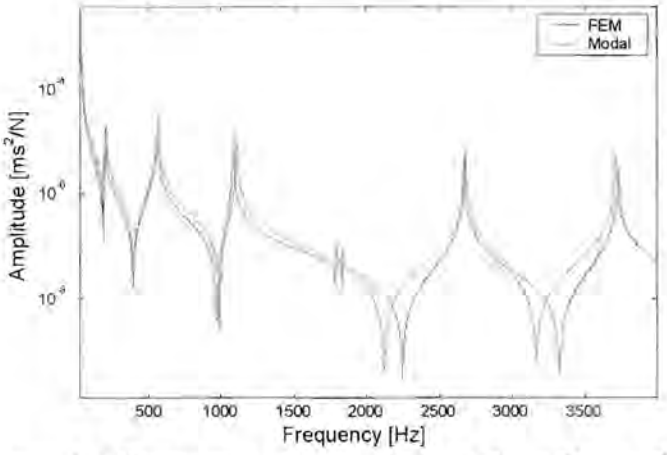

Figure A.1 *Frequency response data at the collocated point*

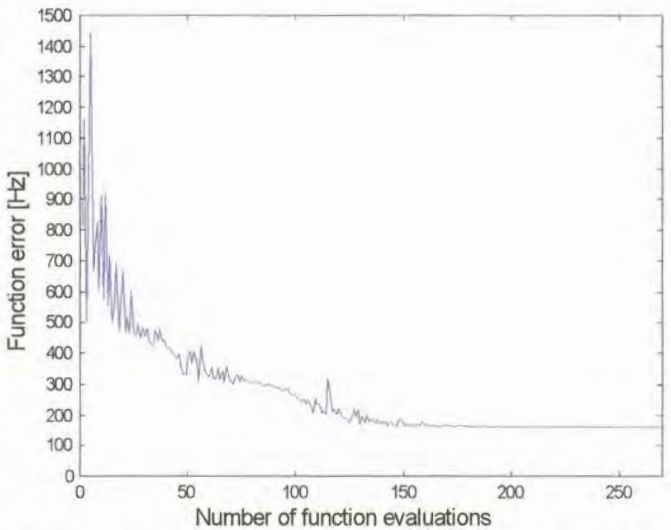

Figure A.2 *The objective function value versus the number of function evaluations*

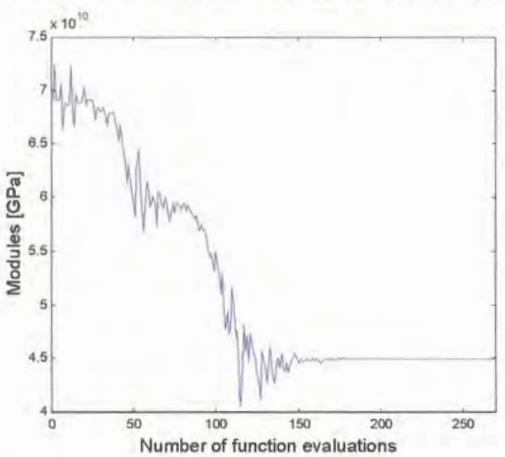

Figure A.3 The Young's modulus value versus the number of function evaluations

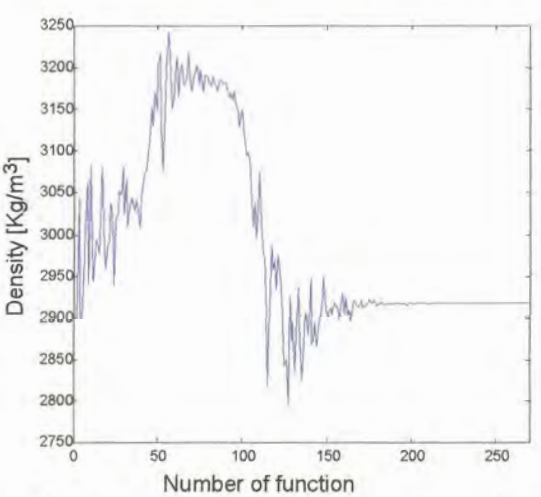

Figure A.4 *The density value versus the number of function evaluations*

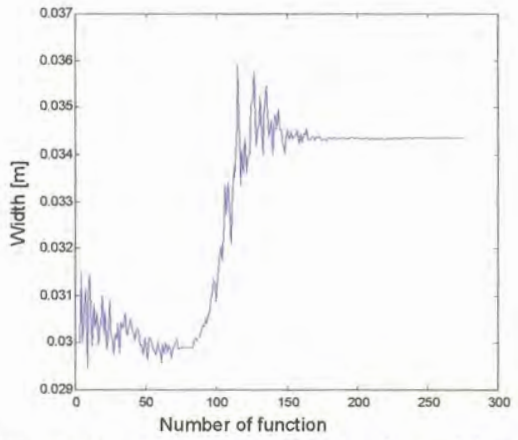

Figure A.5 *The width value versus the number of function evaluations*

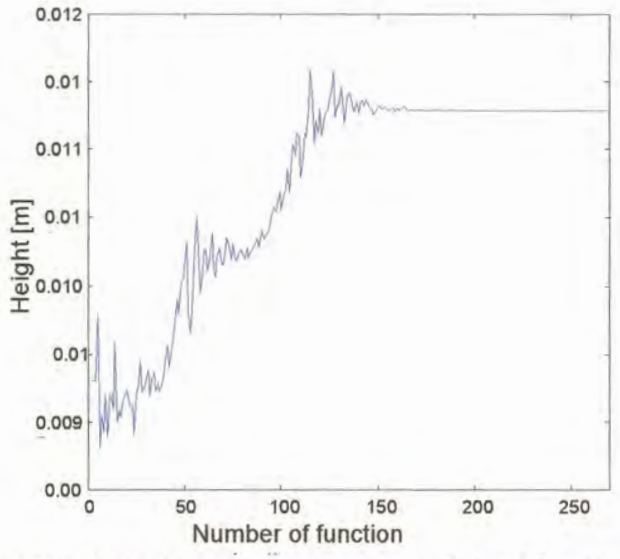

Figure A.6 The height value versus the number of function evaluations

A.1.2 FEM updating results with the actuator

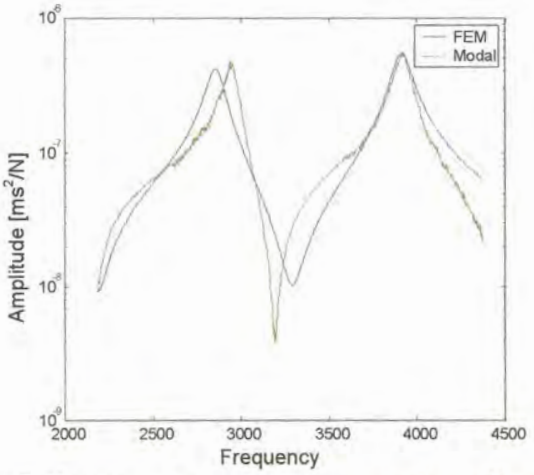

Figure A.7 *Frequency response data at the collocated point*

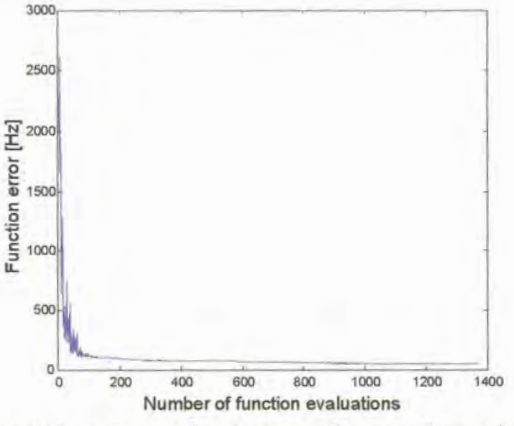

Figure A.8 *The function error value versus the number of function evaluations*

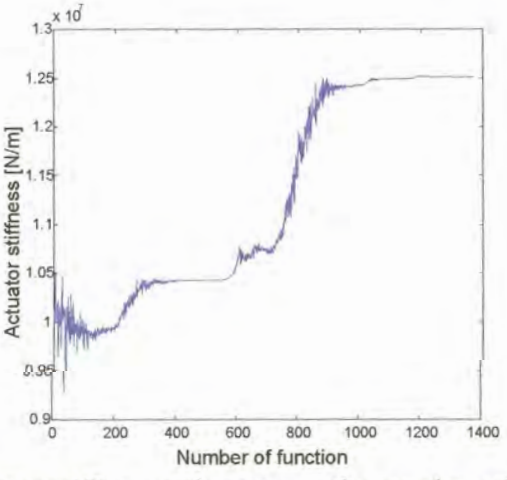

Figure A.9 The actuator stiffness value versus the number of function evaluations

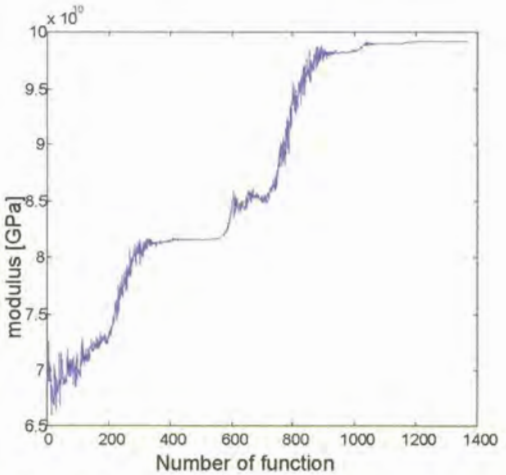

Figure A.10 *The Young's modulus value versus the number of function evaluations*

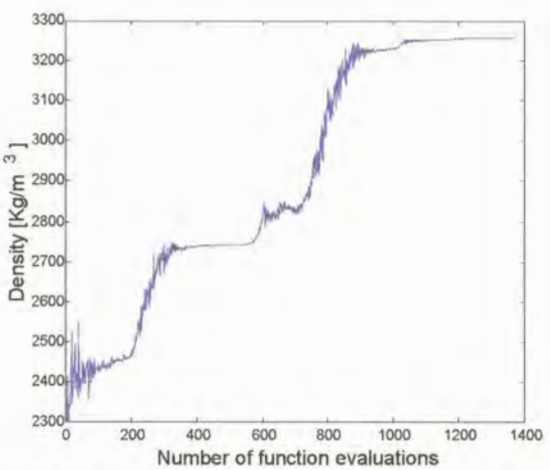

Figure A.11 The density value versus the number of function evaluations

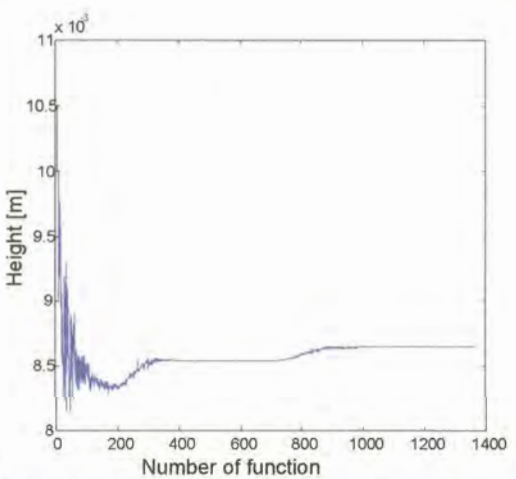

Figure A.12 *The height value versus the number of function evaluations*

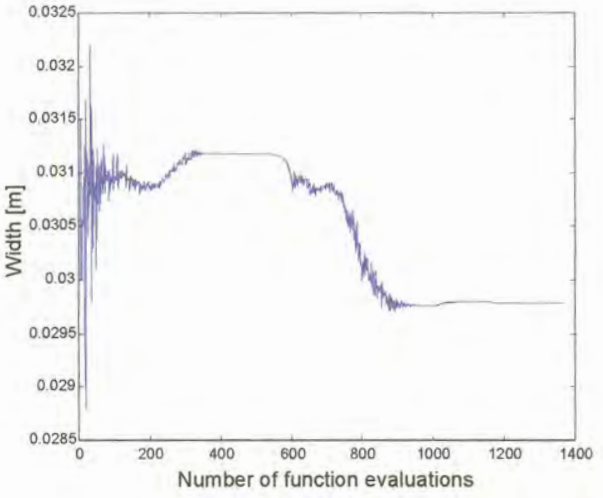

Figure A.13 *The width value versus the number of function evaluations*

A.2 FEM updating results of the tool holder

The tool holder was modelled with beam elements while the support stiffness of the shank and tool changer were represented by 9 spring elements. A schematic diagram of the tool holder is presented in figure A.14.

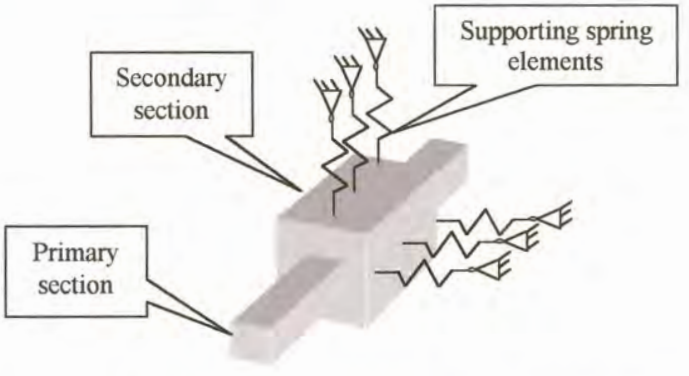

Figure A.14 *Schematic diagram of the tool holder*

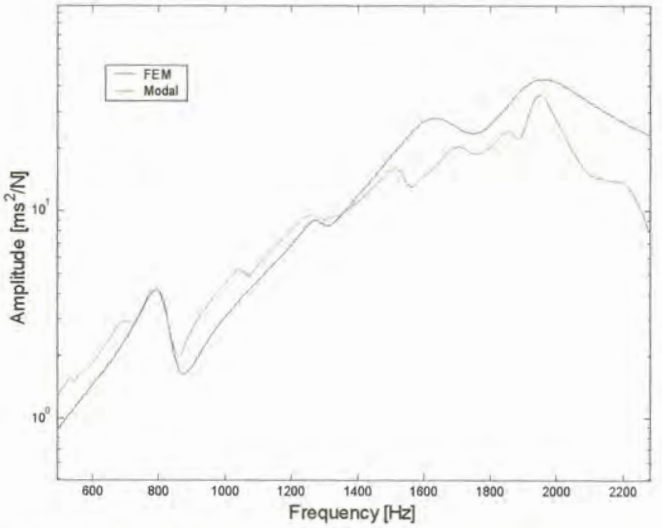

Figure A.15 *FRFs at the tip of the tool holder in the vertical direction*

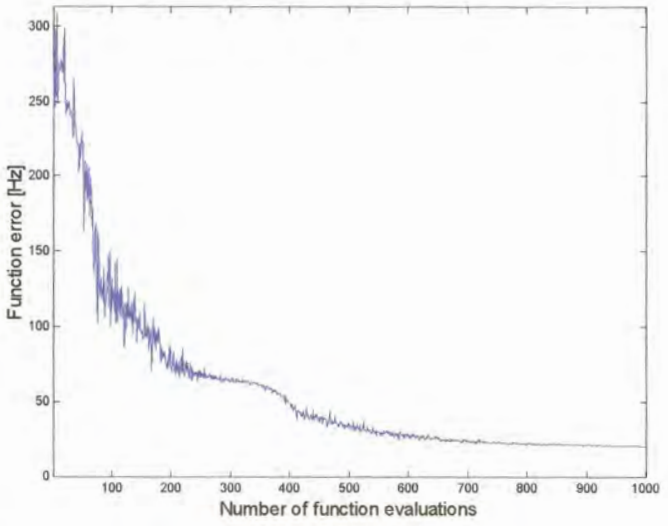

Figure A.16 *Objective function error versus the number of function evaluations*

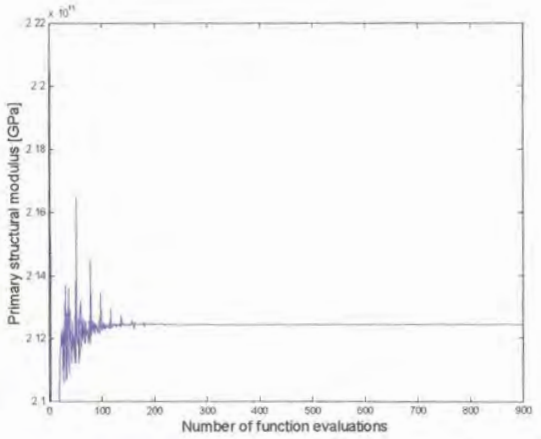

Figure A.17 *Primary structural modulus versus the number of function evaluations*

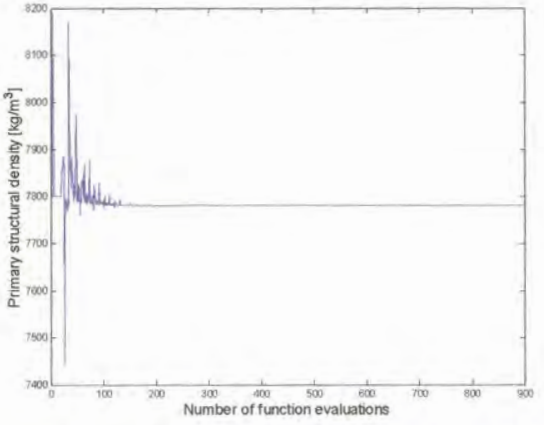

Figure A.18 *Primary structural density versus the number of function evaluations*

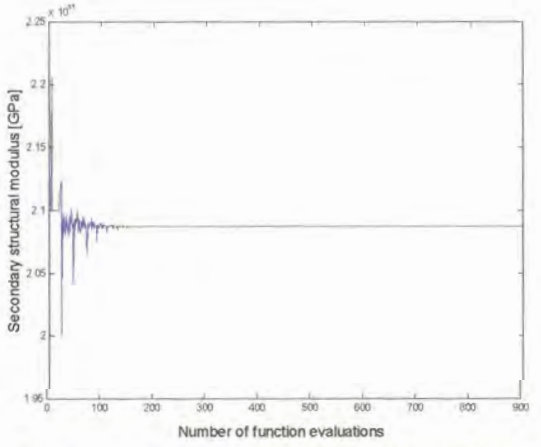

Figure A.19 *Secondary structural modulus versus the number of function evaluations*

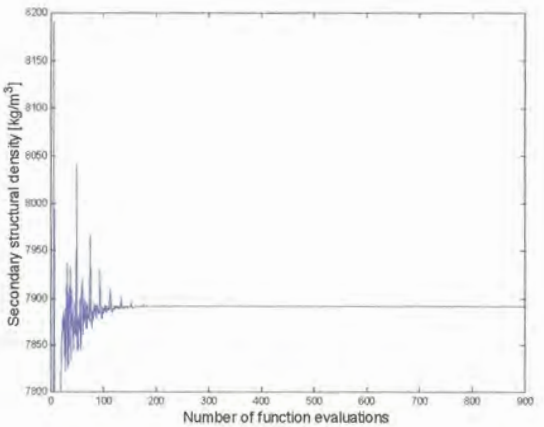

Figure A.20 *Secondary structural density versus the number of function evaluations*

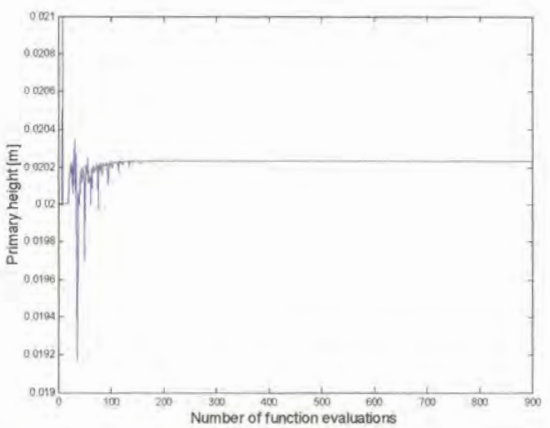

Figure A.21 *Primary beam height versus the number of function evaluations*

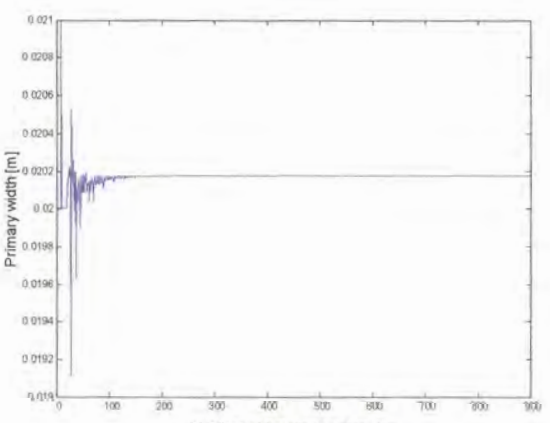

Figure A.22 *Primary beam width versus the number of function evaluations*

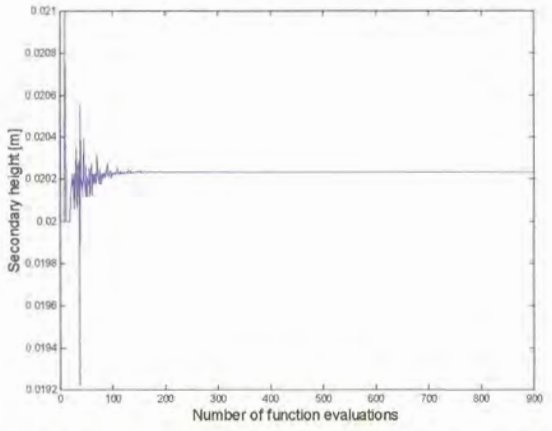

Figure A.23 *Secondary beam height versus the number of function evaluations*

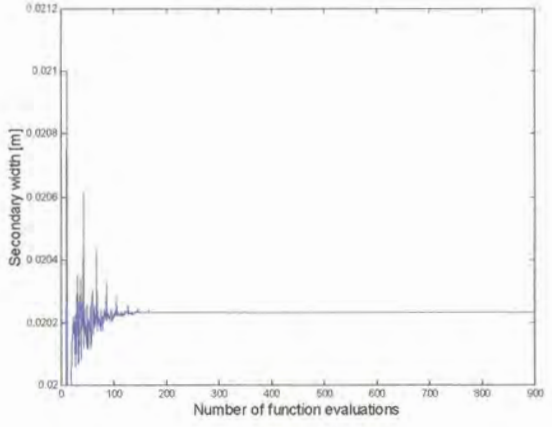

Figure A.24 *Secondary beam width versus the number of function evaluations*

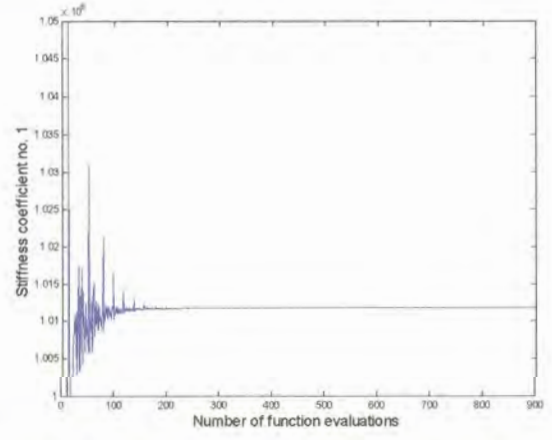

Figure A.25 *Stiffness coefficient number 1 versus the number of function evaluations*

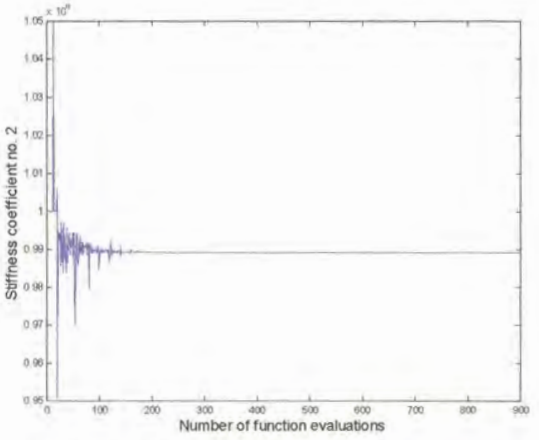

Figure A.26 *Stiffness coefficient number 2 versus the number of function evaluations*

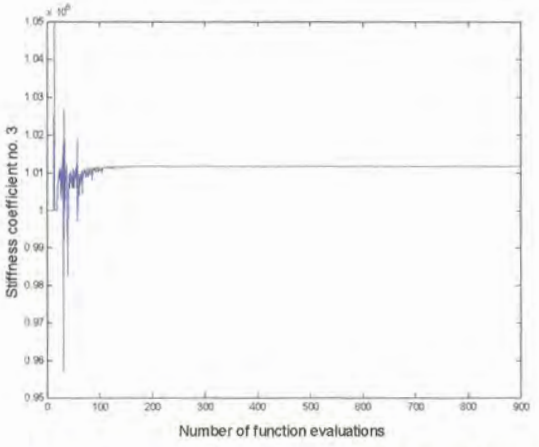

Figure A.27 *Stiffness coefficient number 3 versus the number of function evaluations*

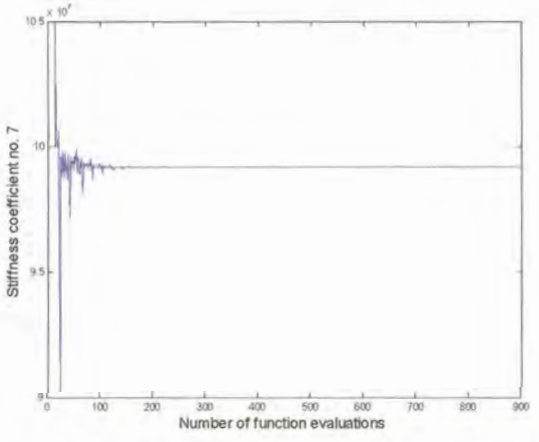

Figure A.28 *Stiffness coefficient number 7 versus the number of function evaluations*

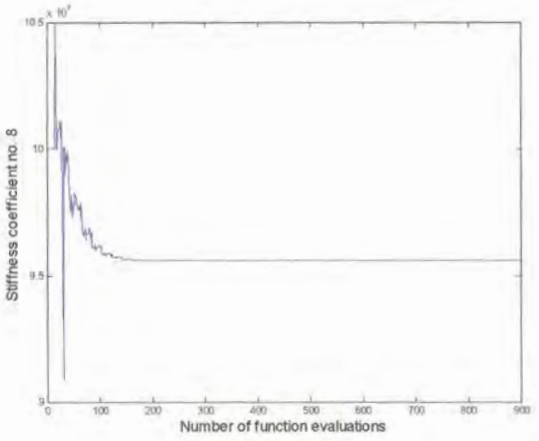

Figure A.29 *Stiffness coefficient number 8 versus the number of function evaluations*

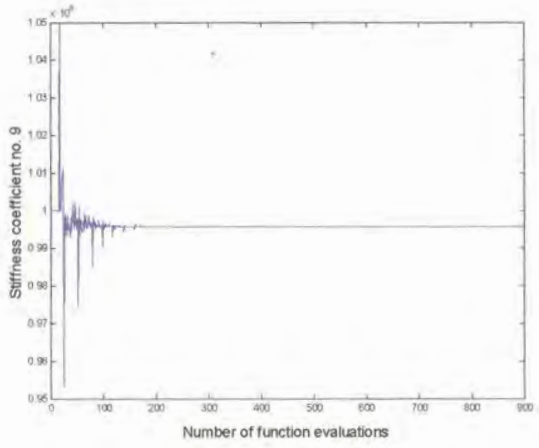

Figure A.30 *Stiffness coefficient number 9 versus the number of function evaluations*

Appendix B

Transmissibility measurements

The transmissibility functions were measured to construct the ODS. The topic is discussed in section 3.1. Details of the machining process is tabled in table 3.1. The figures in the appendix display the measured transmission functions during two separate machining runs under the same machining conditions.

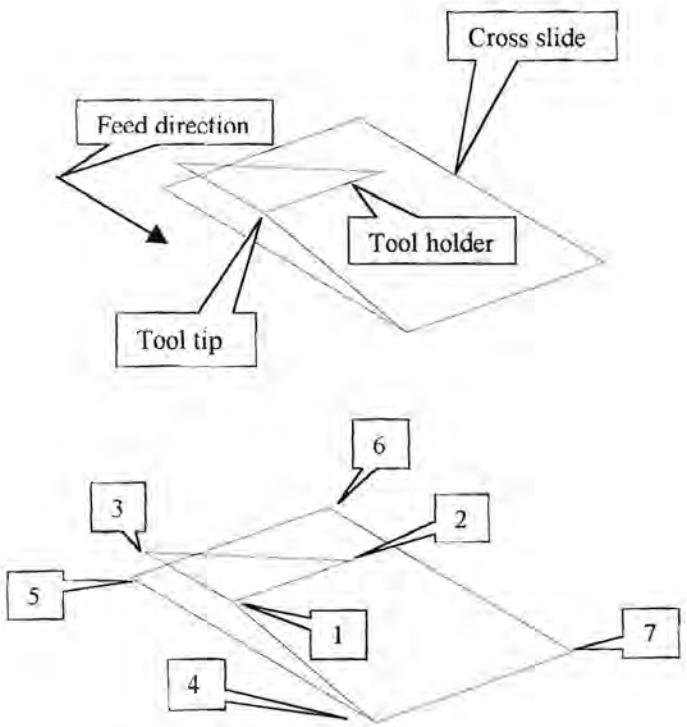

Figure B.1 *Schematic diagram of the transmissibility measurement points*

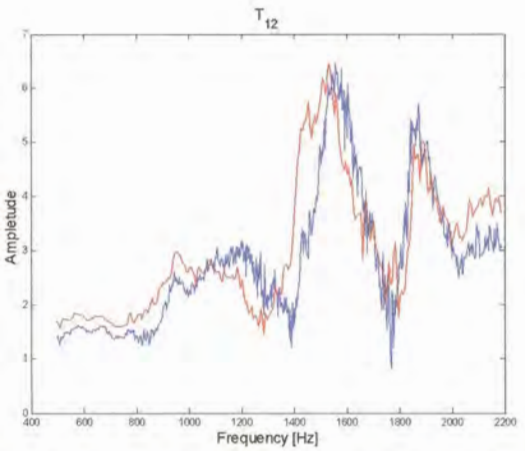

Figure B.2 *Transmissibility function between point 2 and 1 in the horizontal direction*

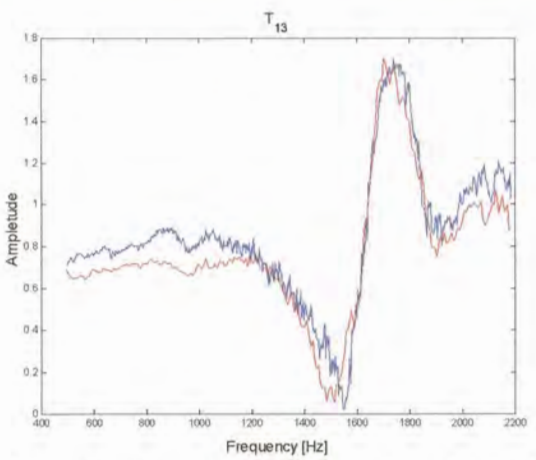

Figure B.3 *Transmissibility function between point 3 and 1 in the horizontal direction*

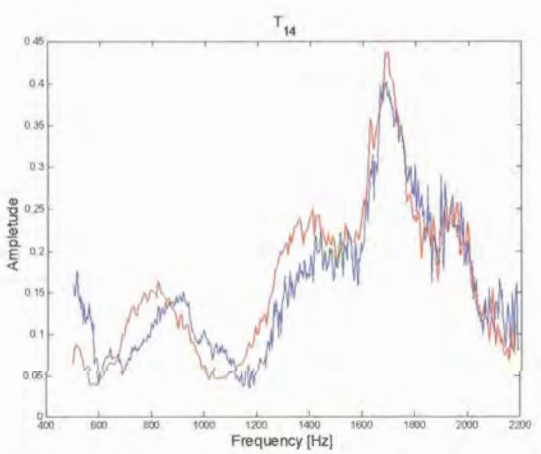

Figure B.4 *Transmissibility function between point 4 and 1 in the horizontal direction*

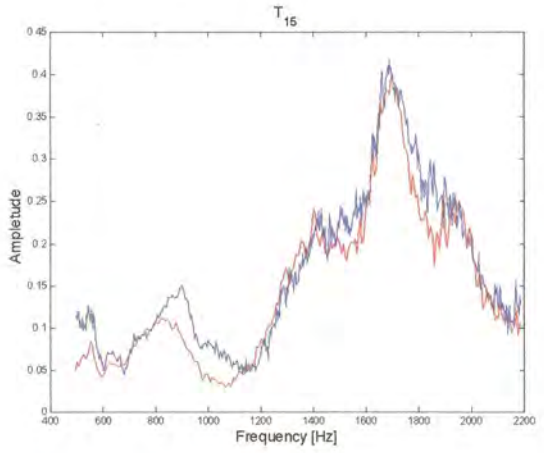

Figure B.5 *Transmissibility function between point 5 and 1 in the horizontal direction*

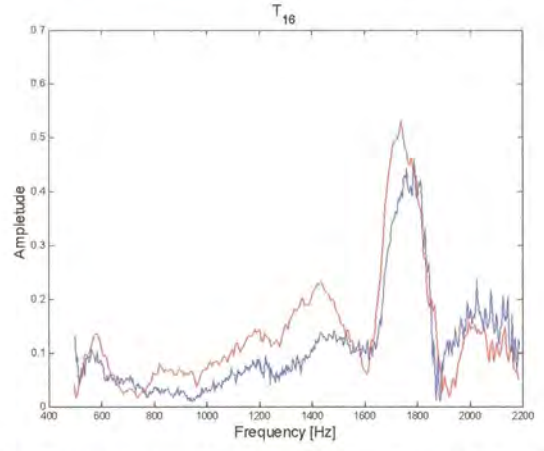

Figure B.6 *Transmissibility function between point 6 and 1 in the horizontal direction*

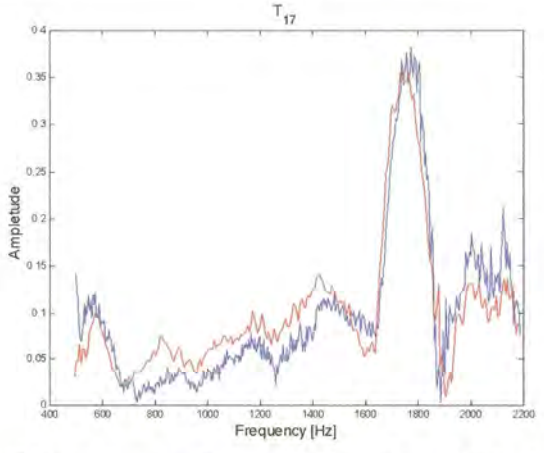

Figure B.7 *Transmissibility function between point 7 and 1 in the horizontal direction*

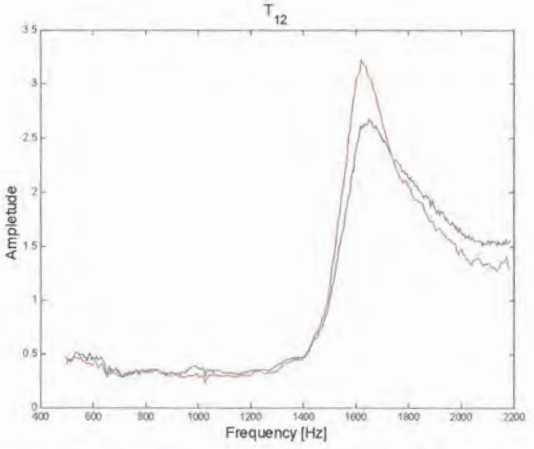

Figure B.8 *Transmissibility function between point 2 and 1 in the vertical direction*

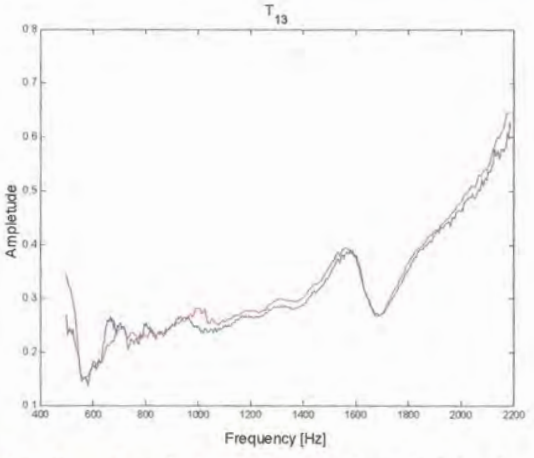

Figure B.9 *Transmissibility function between point 3 and 1 in the vertical direction*

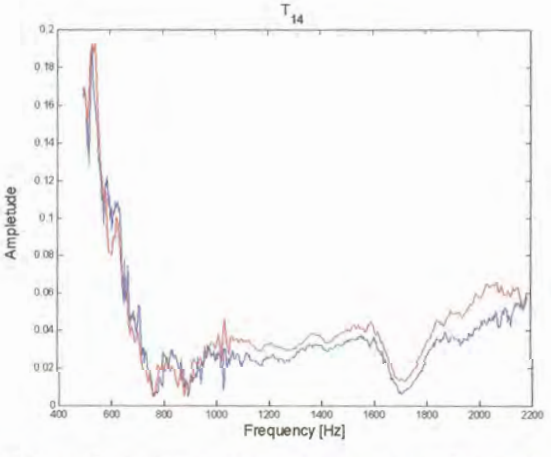

Figure B.10 *Transmissibility function between point 4 and 1 in the vertical direction*

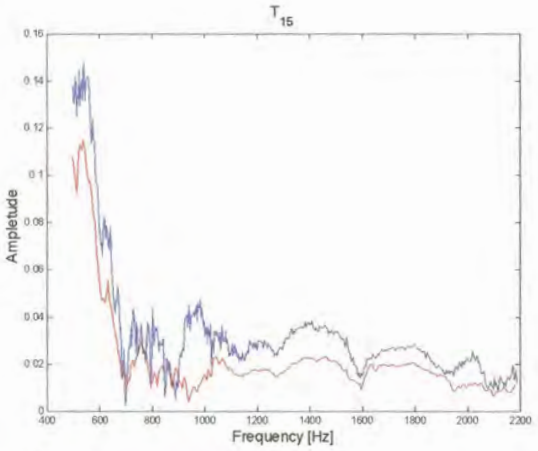

Figure B.11 *Transmissibility function between point 5 and 1 in the vertical direction*

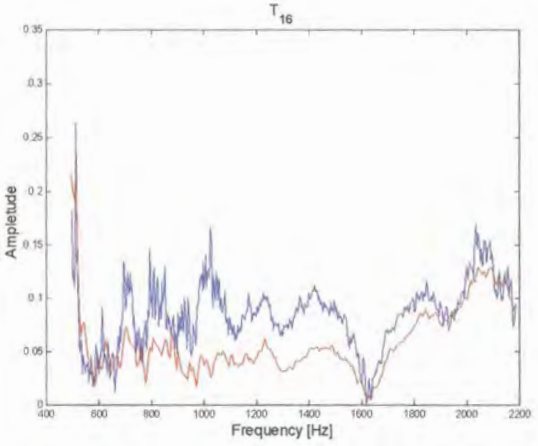

Figure B.12 *Transmissibility function between point 6 and 1 in the vertical direction*

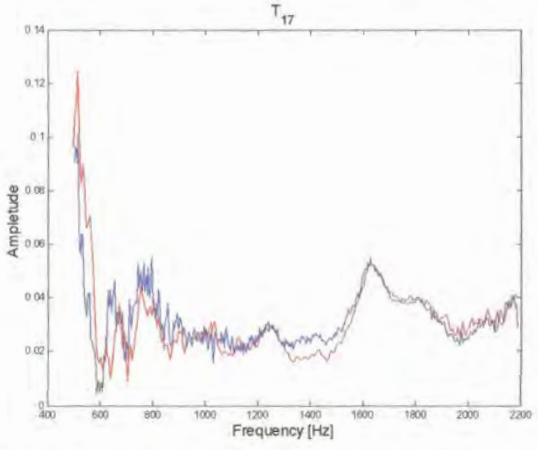

Figure B.13 *Transmissibility function between point 7 and 1 in the vertical direction*