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Experimental Analysis of the Operational Loads on Agricultural Machine

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Abstract. This article deals about experimental analysis of the operational loads on the agricultural machine in real conditions. The goal of this work is to gain boundary conditions which stress frame, joints, screw connections, bearings and other parts of agricultural machines.

Introduction

The agricultural machines are used in the hardest conditions of all machines like cars, transmissions etc. Boundary conditions are for example abrasive soil, dust and load impact created, when working part contacts hard barrier. These machines have to be concurrently characterized by low weight so that low soil compaction is created. Principally roller bearings are the most defective elements on these machines. The load impacts reduce their life. For design of a new type of shock absorber boundary conditions are needed. Position of the critical point of the agricultural machine is shown in Fig. 1.

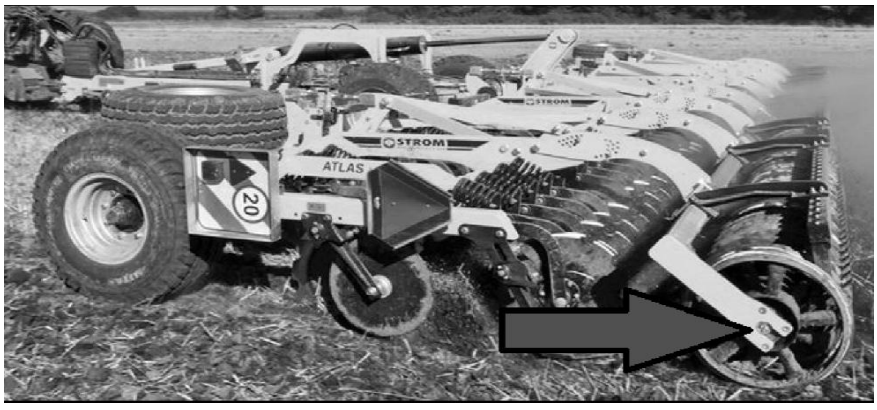

Fig. 1. Disc harrow with critical point.

Analysis of Measuring (Preparation of the measurement)

The position of the measuring point must be close to the bearing. For this reason special supports (equipment for measurement) were designed and manufactured. This support is shown in Fig. 2. The actual and new measuring support can be distinguished, or the expected direction of load and position of strain gauges are shown in Fig. 2. Support was narrowed for high sensitivity to bend strain. This modification was verified using MKP analysis, see Fig. 3. There is expected extreme load stress of 400 N/mm^2 in the narrow place.

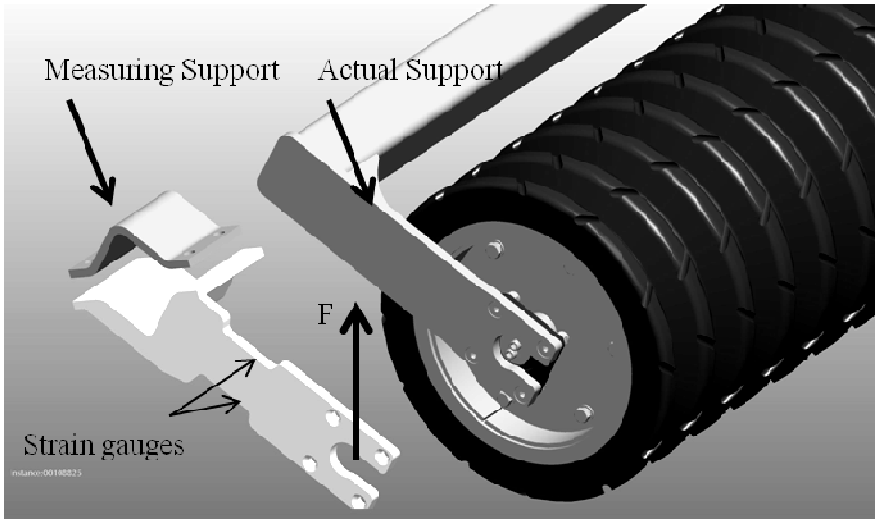

Fig. 2. Measuring support which replace actual support.

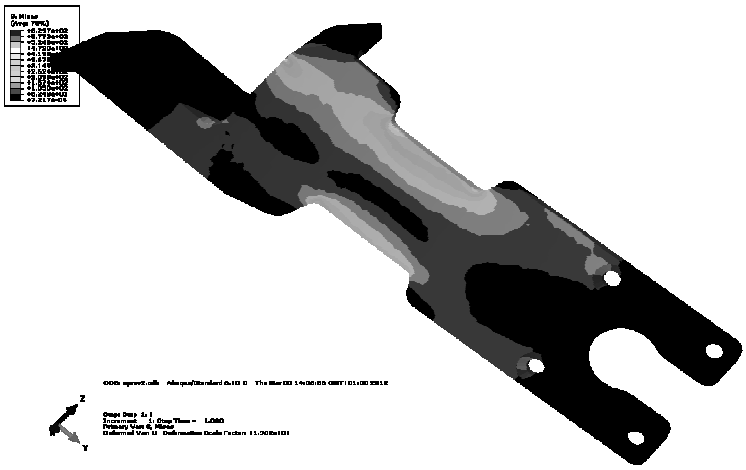

Fig. 3. MKP analysis of measuring support.

Experimental Measuring

Strain gauges installation. The strain gauges were installed on the special supports in the laboratory in the Faculty of Mechanical Engineering, see Fig. 4.

Fig. 4. Strain gauges installation.

Calibration of the measuring support. After installing of the strain gauges, each support was calibrated also in the laboratory in the Faculty of Mechanical Engineering, see Fig. 5.

Force sensor was used, signals from force sensor and from support were recorded and then evaluated. Reasons of the calibration was to get the measuring constant of the measuring supports.

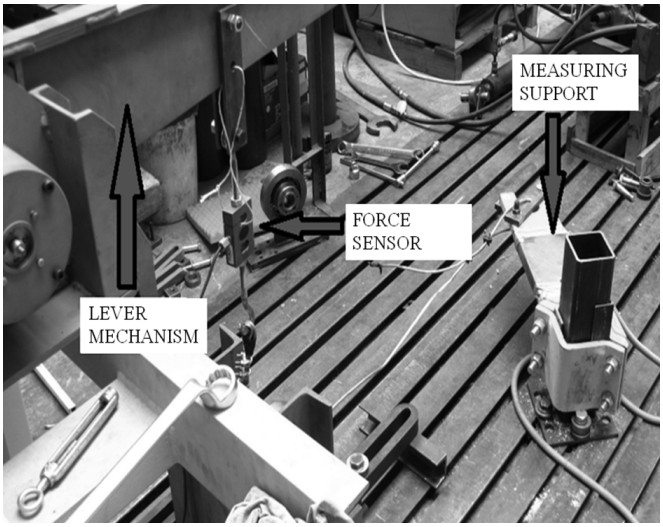

Fig. 5. Calibration of support for measuring operational load in laboratory.

Measuring in the real conditions. Calibrated measuring supports were installed on the machine, and measuring equipment was prepared on the machine. Installation and the measuring equipment have to be protected against dust, water and other mechanical effects like stones during the operation. Measuring of the operational loads was made on the machine in the real conditions.

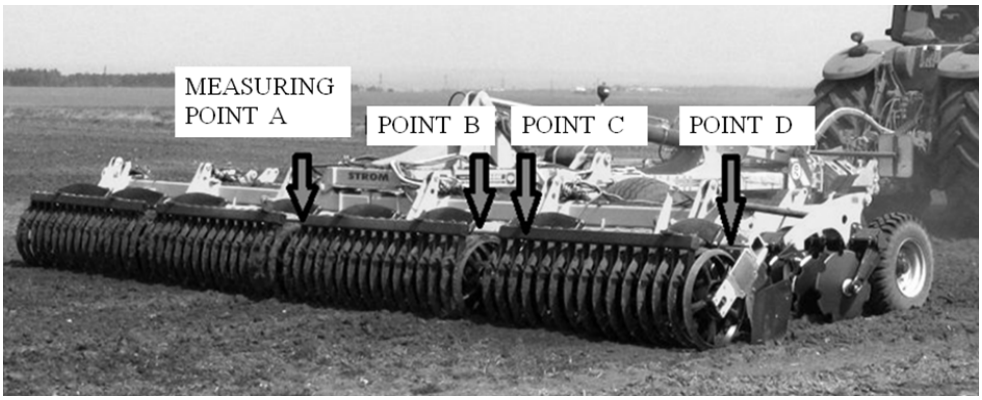

Fig. 6. Measuring points on machine.

Fig. 7. Measuring in real conditions.

Analysis of Measured Data

Four signals were recorded and then transformed in LabView to forces using calibration constants. Scheme of the used program is in Fig. 8. Two signals represent vertical loads and other two signals represent horizontal loads. Vertical loads press on the bearing in radial direction and horizontal loads press on the bearing in axial direction.

Results are plotted in the graph, example of the graph is in Fig. 9. It is possible to distinguish phases, when machine is working and phases, when machine make turn at the end of the field. During the working phase vertical loads were higher than the horizontal loads. In the working phase all the weight of the machine is carried by a tractor and roller. In the turning phase radial loads were negative because machine goes on axle and measuring support hold roller.

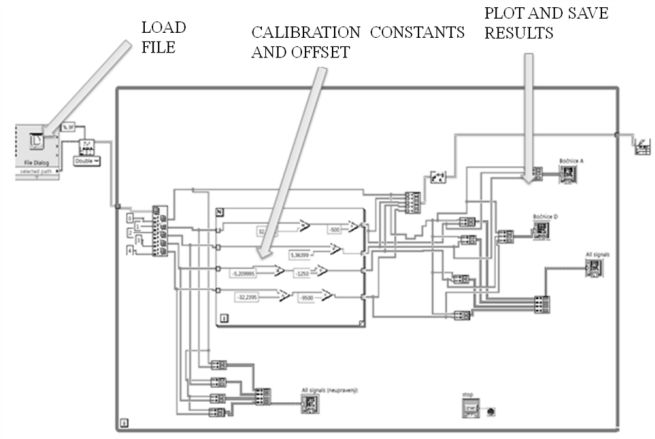

Fig. 8. Software transforming record data to force.

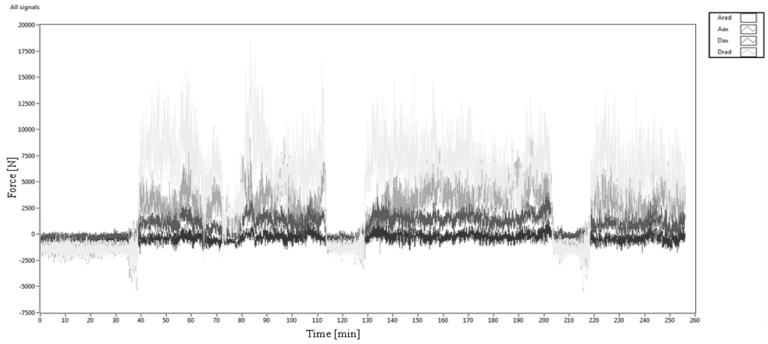

Fig. 9. Data from measuring in real conditions.

Conclusion

This article is cross-section of comprehensive work which contains preparing measuring, calibration of measuring supports and measuring in real condition. Results were used primary for design of a new type of shock absorber. The experience from this measuring will be also useful for testing new parts of agriculture machines.

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References

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