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Experimental Stress Analysis

Determination of the Fatigue Life of the Shank Disk Harrow

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Abstract: Paper deals about experimental investigation of fatigue life of the shank disk harrow. The load spectrum of the part was measured during operation of the machine. Measured data was used as input to fatigue pre-processor PragTic and the fatigue damage was calculated by this program.

Keywords: Shank disk harrow, Fatigue life

1. Introduction

A disk harrow is agriculture instrument and it is used for the foundation soil preparing after crops have been planted [1]. A disc harrow cut of upper layer of soil with a view to disrupt capillary tubes and forbid dehydration of land. Other purpose is blending coppered layer of arable land with plant rest from surface. Turning disc with surface of spherical segment is base working element of the disk harrow. The disk is plunged in soil by the weigh of machine and it is rolled by the forward motion. Working depth is depended on many parameters like as kind and condition of soil, weight of machine, power of tractor etc. Two basic types of disc harrow are produced today. The first one has row off disk on axis and working condition are changed for whole disk composition. The more recent second one has disks separately placed on shank with varied design. The Czech producer of agriculture machines placed on the market the disk harrow of the second one conception. Some shank was broken down during operating life of first generation of this machine, therefore measuring of loading spectrum and calculation of fatigue life of the shank disk harrow was made.

2. Shank Disk Harrow

The shank disk harrow consists of two main parts, as can be seen in Fig. 1. The first one is spring part made from square rod with cross area dimension 40x40 mm and used material is ČSN 14 260.8. The second part is holder of bearing block with a disk. Whole part can be seen in Fig.2. The shank is fixed to the main construction of the disk harrow. As mentioned earlier, some shank was broken down, when area of

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failure is in place C in Fig.2. Because operational condition on the disk part are various and ambiguous and with regard to place of failure it was decided, that will be measured a inner forces and moments in place A (Fig. 1) and this loads be used for loading spring part of the shank only.

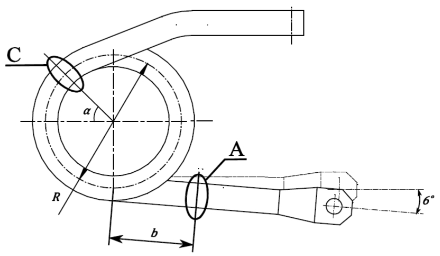

Fig. 1. Situation diagram of shank disk harrow. Place A – strain gauges area. Place C – area of failure.

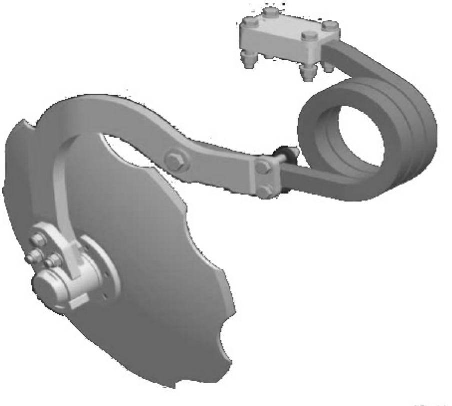

Fig. 2. Situation diagram of shank disk harrow.

3. Experimental part

3.1. Preparation of experiment

The strain gauges ware installed in place A for investigation of inner forces and moments how is shown in Fig. 3.

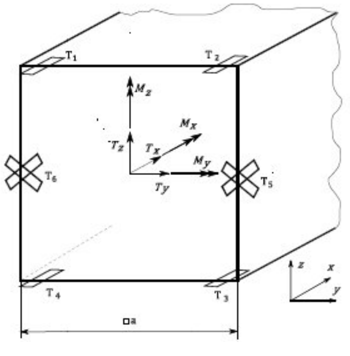

Fig. 3. Strain gauges placement.

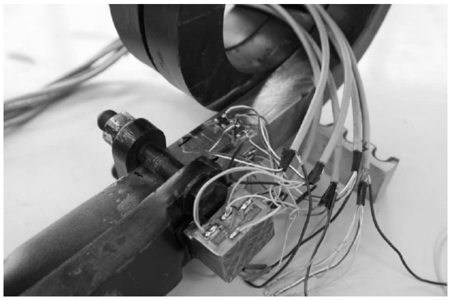

Fig. 4. Installed strain gauges and the dummy gauges.

Axial strain gauges HBM LY11 6/120 ware used in places from T1 to T4 and half bridge circuit was completed with strain gauges dummies installed on unloaded piece of the shank material. Normal force T_x and bending moments M_y and M_z is possible determine from the strains measured by this strain gauges. Strain gauges HBM XY21-2/120 ware installed in place T5 and T6 and measured signal was used for determination of shearing force T_z and torsion moment M_x. All strain gauges ware bonded by means adhesive Z 70 and covered by protective coating ABM 75, both produced by HBM.

3.2. Measurement

Prepared shank was installed in first row of disk harrow. Measurement unit HBM Spider 8 with independent power supply was used for data acquisition. Spider 8 controlled by software CatmanEasy was placed in tractor cab. A sample rate 2.4 kHz was used during measurement. The disk harrow operated in both normal working condition and abnormal loading during u-turn on field end although u-turn with disk in working position is forbidden by manufacturer.

Fig. 5. Disk harrow during measurement.

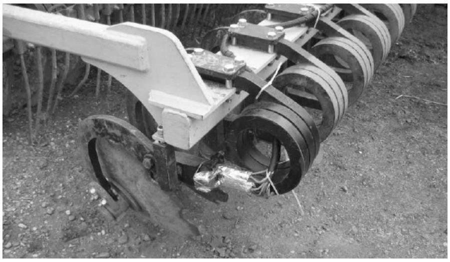

Fig. 6. Shank disk harrow during measurement.

3.3. Data evaluation

Measured data was reduced by average filter and acquired strains signals ware used for determining inner loads in place A. by means of analytical solution [2]. Correct coefficient for determination torque moment and shear force was computed by FEM.

4. Fatigue life determination

Program Pragtic [3] was used for evolution fatigue life of the shank disk harrow. Pragtic software is freeware tool for a fatigue damage calculation based on FE-solution. In case of multiaxial loading are computed loading situation with only one load component and using principle of superposition and application measured behaviour of forces and moments can be calculated fatigue damage of investigated construction.

During FEA of spring part of the shank was found out geometrically nonlinear displacement results with high level of loading corresponding with level measured during u-turn process. That is a reason of height value of fatigue damage calculated on same shank places. Regarding those results was made calculation only for loading spectra acquired during working condition prescribed by disk harrow producer. LESA method was used for final calculation and was obtained fatigue damage D =0.000045. Distribution of fatigue damage on shank is represented in Fig.7

Only strength and yield strength ware available for used material, therefore fatigue limit was calculated approximately.

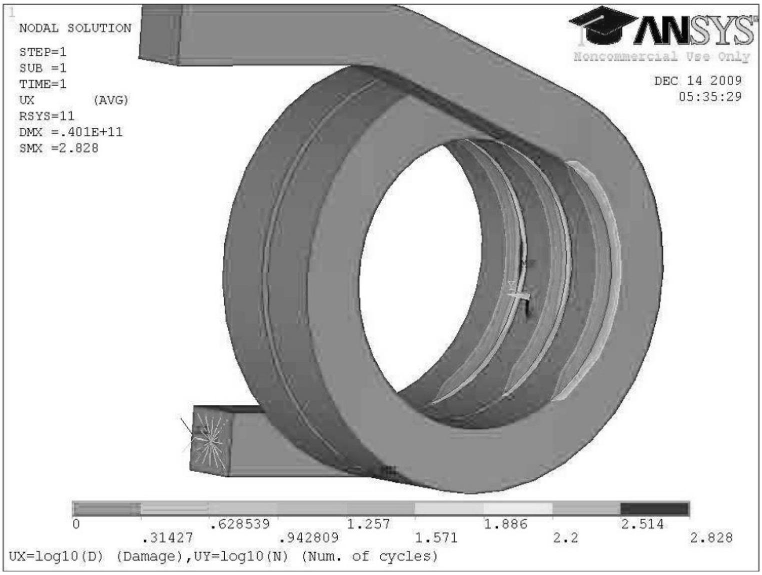

Fig. 7. Distribution of calculated fatigue damage on shrank. Visualisation by means ANSYS postprocessor.

5. Conclusion

Strain gauges ware used for acquiring inner load spectra in one place of shrank disk harrow. Load spectra was used as input for software Pragtic and by means of this programme was calculated fatigue damage of shank. By reason of nonlinear condition during u-turn section was this loading section omitted. It was calculated fatigue damage D=0.000045. This result indicates that is possible cultivate a circa 3900 ha of land for similar condition.

References

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[3] "PragTic Freeware Project" *Available from* http://www.pragtic.com *Accessed:* 2009-12-03.