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Dynamic Analysis of Opener Set of Planter

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ABSTRACT

In order to approach a natural response of a mechanism which is exerted an external load, using the theory of flexible materials can be useful .Hence in this research, the opener set of a no-till planer (Gaspardo Directa 300) was simulated with Catia software and then in order to determine the dynamic analysis these mechanism and its components were imported in ADAMS software and the behavior of them were investigated in four different conditions. After that , according to the loads applied to the cutting chassis system, dynamic analysis with Abaqus software has been done, and using the theory of flexible materials, the stress parameters and strain behavior of the cutting chassis system in different conditions were analyzed. The results showed that with increasing 99 percent in the load, stress and strain in the cutting chassis system increased 256 and 253 percent respectively.
KEYWORDS: Dynamic Analysis, opener set, no-till planter , Adams, Abaqus.

1-INTRODUCTION

Using the engineering software in computer aided design, computer aided engineering and computer aided manufacturing field, nowadays is undeniable to solve and analysis of engineering projects [1]. One of the most important factors that affected the performance of a advanced technology is the study of dynamic behavior of mechanisms [2].No tillage is a kind of conservation tillage, in which seeding operation of cultivation do without more primary and secondary tillage operations [4]. Finite Element (FE) is one of those methods which used for evaluation of a structure under static and dynamic loads before making the main model. This leads to improve the strength of our design. Ansys is a general purpose software package based on the finite element analysis[6 and 7]. Finite element method was used by many researchers in order to design the tillage tools or investigate the interaction between soil and tillage implement. Most investigation used a blade as the object studying the interaction between soil and tool, because its geometric simplicity made the corresponding FEM analysis relatively easier[8,9,10,11].

The Italian Gaspardo Directa 300, is one of the most conventional no-till planters which is used in Iran [3]. Changing in situations of planter cutting system occurs, because of dealing the cutting system with the inscrutable barriers. Because of reception the impermeable barrier, the springs system used in cutting mechanisms ,were activated.

In this study, to consider the loads that exert to cutting system the Gaspardo opener sets mechanism was simulated by Catia software. Then, two components of the mechanisms used in this opener set imported to Adams software and constraints between the mechanisms components established and simulated. Adams is one of the strongest, most widely known trains of mechanical systems simulation software. The amount of spring's deformations, used in the mechanisms , was considered as a criterion of inscrutable obstacles. In four different modes of spring's deformations, the forces that created . These deformations, calculated using the Adams software and the force of the connectors on the cutting chassis system were measured in the state of motion. Finally the cutting chassis was imported in Abaqus software and by the values obtained in previous section, regarding the actual chassis supports and loads of them in the state, stress and strain were calculated.

2-MATERIALS AND METHODS

2-1-cutting system simulation with Catia

In this section, cutting system used in the Gaspardo no-till planter (Fig.1) separately simulated and assembled using Catia (Fig. 2).

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Fig1. Gaspardo no-till planter opener set.

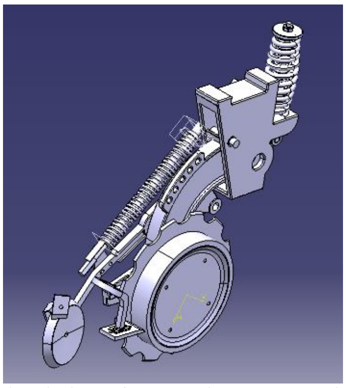

Fig 2. Simulation of Gaspardo opener set in Catia.

2-2- Importing the opener set into the Adams

At this stage component of the releasing mechanism and the pressure wheel was individually imported into the Adams (Figs. 3 and 4).Weight, center of mass coordinates and mass moment of inertia values for each item were calculated by the Adams. The motion simulation was done by creating the appropriate constraints between components of the mechanism and four different forces were applied to them (forces were 20, 30, 40 and 50 Newton).The stiffness of two springs were 3 (kN/m) and 10 (kN/m).

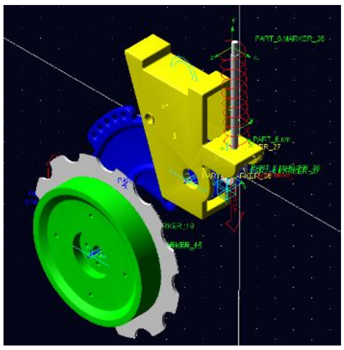

Fig 3. Simulation of the 1st mechanism components in Adams.

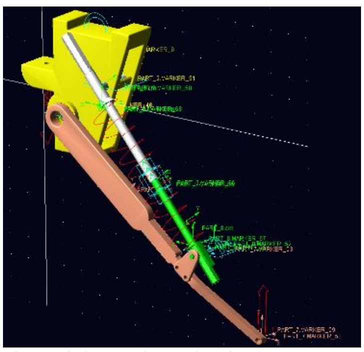

Fig 4. Simulation of the 2nd mechanism components in Adams.

Due to contact the impermeable barrier, the compression springs were activated in hinge-spring joint of releasing cutting set systems (Fig.3).Non-parallel four-bar linkage used in pressure wheels mechanism, controls the amount of pressure on grooves with opener and causes the appropriate connection between seed and soil (Fig. 4).In this stage the loads exerted to the chassis opener of set mechanisms joints, were measured when the mechanism was moving.

2-3- Importing Cutting set into the Abaqus

At this stage, chassis of the cutting set that was simulated in Catia software imported into the Abaqus software. According to the real supports and the loads that obtained from dynamic analysis in Adams, analysis in four different situation was done (Fig.5). In static analysis because of the specific shape of the chassis opener set, tetrahedron elements (C3D4, 4-node linear tetrahedron elements) were used. Material characteristic of the chassis were, young modulus 2×1011 and Poisson's ratio 0.266 (steel).

Fig 5. The opener chassis layout supports and loads in Abaqus.

3-RESULTS AND DISCUSSION

3-1-The results of dynamic analysis of mechanisms

This section includes the loads calculation of opener chassis, when the springs were deformed in four different status (Figs 6 and 7 and Table1).

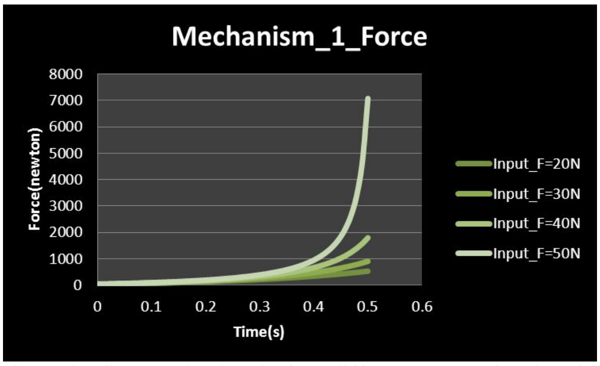

Fig 6. Loads on the first mechanism in four different status of spring deformation.

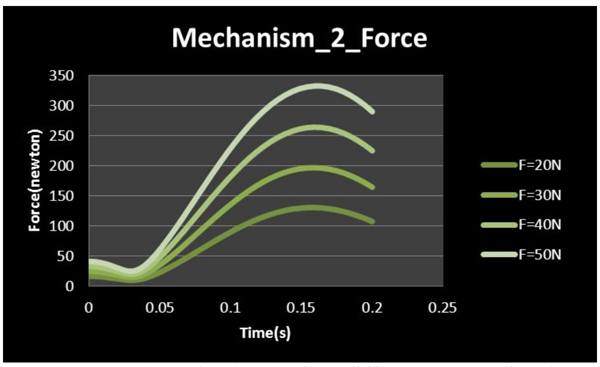

Fig 7. Loads on the second mechanism in four different status of spring deformation.

Table 1. Values obtained from the dynamic analysis of mechanisms

Force (newton)	*Mechanism Number*	*Max Force (newton)*	*Min Force (newton)*	*Spring deformation (mm)*
F=20	1	529.4146	16.6602	85.0483
	2	130.7046	9.9199	32.964
F=30	1	904.97	25.1201	86.172
	2	196.9716	14.9255	44.751
F=40	1	1794.399	33.5802	87.3693
	2	264.182	19.9741	55.863
F=50	1	7076.952	42.0404	88.624
	2	332.6131	25.0712	66.407

3-2- Results of the static analysis of the opener chassis

This part contains the results of the stress and strain calculation exerted on the opener chassis, according to the loads that were obtained from the previous stage (Figs.8-11).

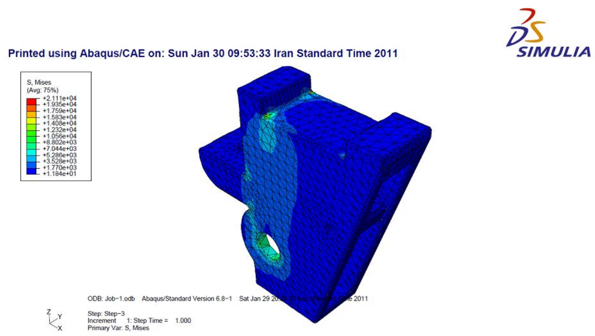

Fig 8. Schematic view of the opener chassis according to applied loads.

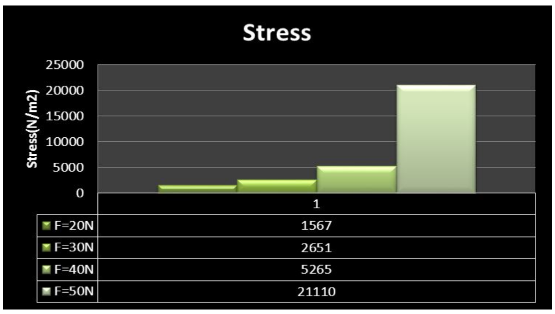

Fig 9. Comparison of maximum stress due applied loads that cause changing conditions over the mechanisms.

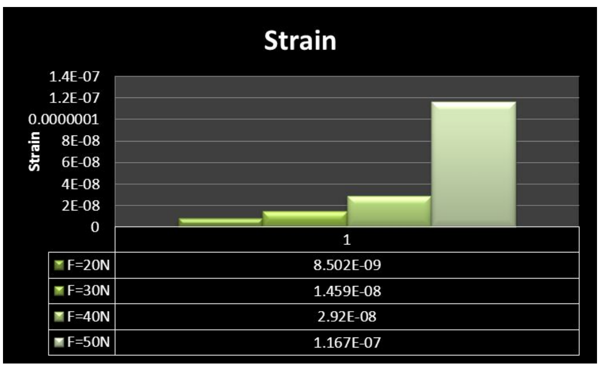

Fig 10. Comparison of maximum strain due applied loads that cause changing conditions over the mechanisms.

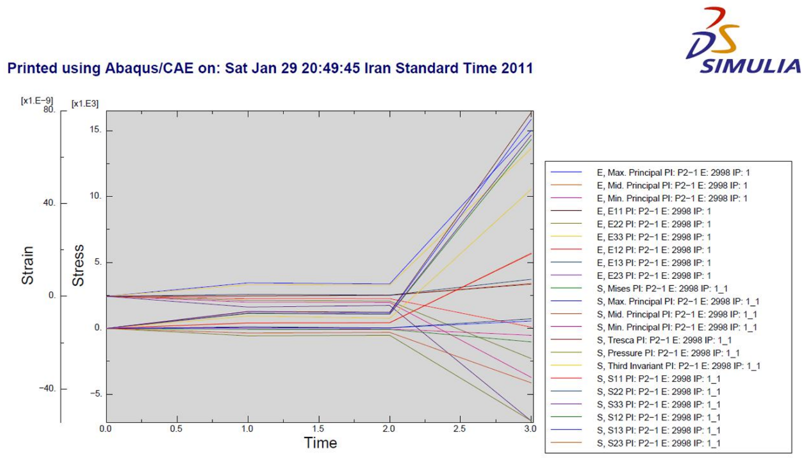

Fig 11. Maximum stress and strain applied into the opener chassis at supports

At the first status, the first mechanism according to applied force (20 Newton), had 85 mm deformation. On second mechanisms, at that condition, deformation was 32 mm.

This deformations cause the stress and strain of 1567 Pascal and 8.5×10-9 on the system chassis from the first and second mechanisms. At the second status, the first mechanism according to applied force(30 Newton), had 86 mm deformation. On second mechanisms, at that condition, deforming was 44 mm. This deformations cause the stress and strain of 2651 Pascal and 1.4×10-8 on the system chassis from the first and second mechanisms. At the third status, the first mechanism according to applied force(40 Newton), had 87 mm deformation .On second mechanisms, at that condition, deforming was 55 mm. This deformations cause the stress and strain of 5265 Pascal and 2.9×10-8 on the system chassis from the first and second mechanisms. At the fourth status, the first mechanism according to applied force (50 Newton), had 88 mm deformation .On second mechanisms, at that condition, deforming was 66 mm. These deformations cause the stress and strain of 21110 Pascal and 1.1×10-8 on the system chassis from the first and second mechanisms

4- Conclusion

In the Changing from first to second, with increasing 33 percent of the applied load to the first and second mechanisms, the length of springs were decreased 1 and 27 percent respectively. These were caused to increase of 42 and 39 percent of stress and strain applied to the opener chassis respectively. In the Changing from second to third, with increasing 66 percent of the applied load to the first and second mechanisms, the length of springs were decreased 2 and 47 percent respectively. These were caused to increase of 49 and 51 percent of stress and strain applied to the opener chassis respectively. In the Changing from third to fourth, with increasing 99 percent of the applied load to the first and second mechanisms, the length of springs were decreased 3 and 67 percent respectively. These were caused to increase of 75 and 73 percent of stress and strain applied to the opener chassis respectively. In the overall we can conclude that ,with increasing 99 percent in the load, stress and strain in the cutting chassis system increased 256 and 253 percent respectively.

Acknowledgment

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