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The Transient Dynamic Analysis of multi-stage Fork of Stacker

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Abstract. A certain type of tunnel stacker multi-stage fork model was built by the software of SOLID-WORKS. This model was imported ANSYS to establish the FEA model and simulation its characteristic of transient dynamics. Through the simulation, characteristic of transient dynamics was obtained and found the key parts of the fork structure. This result is the foundation for next design and improvement.

Keywords: Tunnel stacker; Multi-stage fork; ANSYS; Transient dynamic

Introduction

The fork mechanism is working device of the stacker in automated high-rise warehouse used to access goods [1]. Because of restrictions of structural arrangement, length of fork less than the width of the roadway and the extended length is often greater than their length, so multi-stage forks is adopt, and fork at all levels between the plate and make doubling achieved through travel large distances stretch the purpose. When access to goods, position need ensure accurate and multi-stage fork must have sufficient strength and rigidity. The fork plate is required minimum distortion, most vibration, minimal radiation noise, so that we need to study the dynamic characteristics. Through suppressing vibration and optimizing the structure, the dynamic stiffness and dynamic strength of the multi-stage fork will be improved. Therefore, it is necessary to carry out the whole transient dynamic analysis.

Establish entity model

SOLID-WORKS has powerful solid and surface modeling capabilities, and ANSYS finite element analysis has perfect function. SOLID-WORKS and ANSYS can be completely interfaced. So, SOLID-WORKS was used to solid modeling, and then imported the model in ANSYS finite element to analysis.

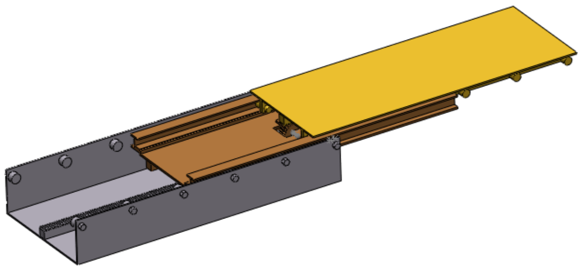

Fig.1 Fork Mechanism

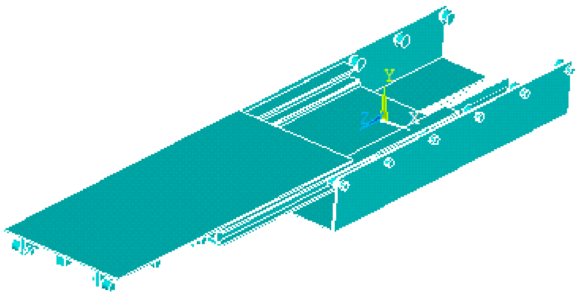

Fig.2 Import model

Power-driven and upper, middle and end of the trigeminal and guiding parts comprise the fork of three linear differentials. with rollers under the fork side and fixed on the bench cargo platform, middle fork of the lower plate and the word line rail connected to the top plate and fork on a vertical plate is connected to the vertical board with wheels. Fixed rack fixed to the lower fork, and gear fixed on the fork, and the driven rack fixed to the upper fork. Good first constructed a model of each fork plate, and then the upper, middle and lower three panels in SOLID-WORKS fork

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assembly module assembly for the whole three-dimensional solid model, shown in Figure 1.

The finite element model is established [2-3]

Interface configuration of SOLID-WORKES with ANSYS. The model was shown in figure 2.

Mesh Generation. The stacker fork into the model as whole, materials is A3 steel, modulus of elasticity is 2.06 * 108, Poisson's ratio is 0.3, and unit type is SOLID45. Network partition is free. Smart size was used to control the generation of network quality. The whole network is divided over a total of 35376485586 nodes, as shown in figure 3.

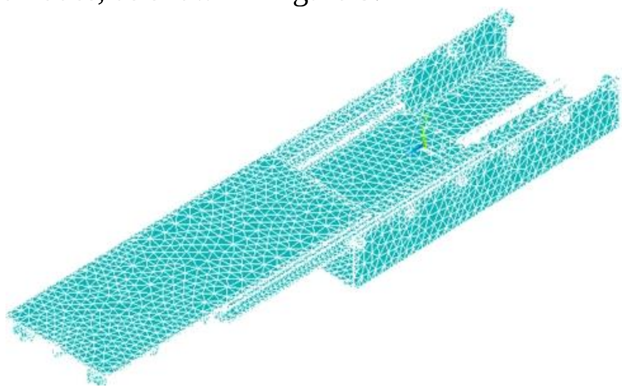

Fig.3 Finite element model

Transient dynamic analyses [4-6]

Transient dynamic analysis (also known as the time history analysis) is a method for determining the dynamic response under arbitrary time-varying load structure. Structure in the static load, transient load and harmonic load under the combined action of the random time-varying displacement, strain, stress and the force were established by Transient dynamic analysis.

Theoretical basis of transient dynamic analysis. The basic motion equation of transient dynamics is follow:

$$[M]\ddot{\delta}(t)+[C]\dot{\delta}(t)+[K]\delta(t)=\{F\}$$

Among them, [M] is the mass matrix, [C] is damping matrix, [K] is the stiffness matrix, the displacement vector $\delta(t)$ is a function of time t, the velocity vector $\dot{\delta}(t)$ and acceleration vector $\ddot{\delta}(t)$ are one order and two order derivative of the displacement vector $\delta(t)$ of time t. load vector $F(t)$ is a known function of time.

Load transient dynamic loading. When the goods fork stretch the maximum distance forks goods, structure vibration caused by shock moment, will make the three fork plate to generate the displacement in the vertical direction. This paper selects the fork out of maximum distance as the control point.

Stacker fork take goods, impact loading process finite element model fork as shown in figure 4.

According to figure 4, load impact excitation curves of loading impact load F (t):

$$F(t)=\begin{cases}\dfrac{mg}{t_1} & t\in(0-t_1)\\ mg & t\in(t_1-t_2)\end{cases}$$

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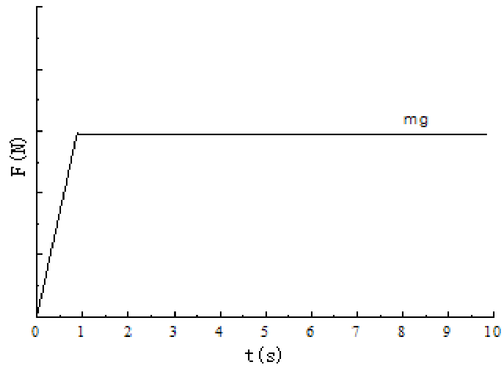

Fig.4 Impact load

The result of transient dynamics. The results of at a given point in time of the model was observed by ANSYS universal post processor (POST1), and the processor in the time courses (POST26) refers to a point appears as a function of time results in the observation model. In the POST26 post processor, model in solving each load step after the completion of Yon Mises stress results as shown in Figure 5 and 6.

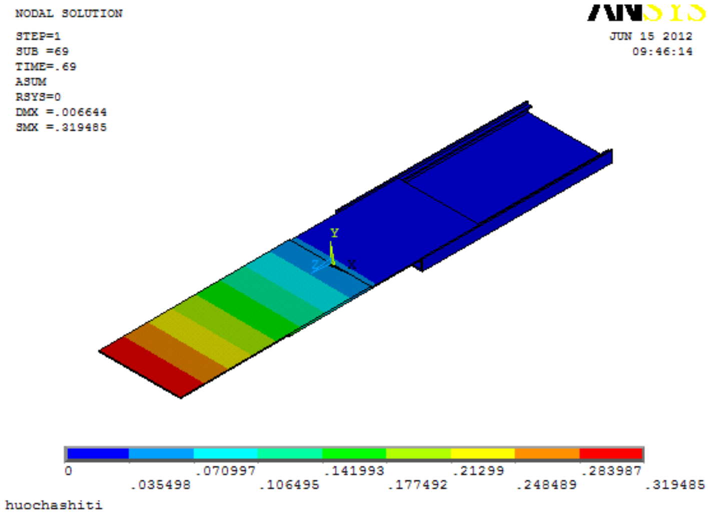

Fig.5 1st step of the Von Mises stress distribution

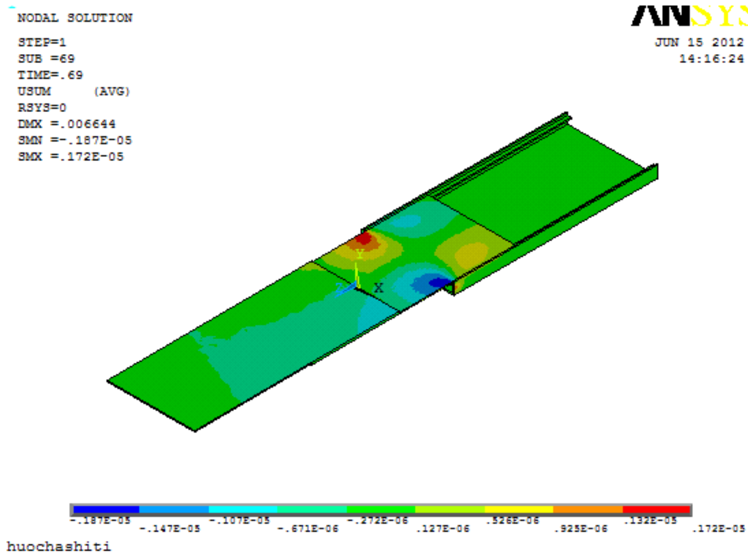

Fig.6 2st step of the Von Mises stress distribution

The number 447 of middle fork at the front of and of the maximum stress point parameters node 8574 of the second were extracted. Time-displacement curve of node 447 as shown in Figure 7, number 8574 in Figure 5 node time-displacement as shown in Figures 8-10 are the 447 node

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time-stress curves and 8574 node time-stress curves.

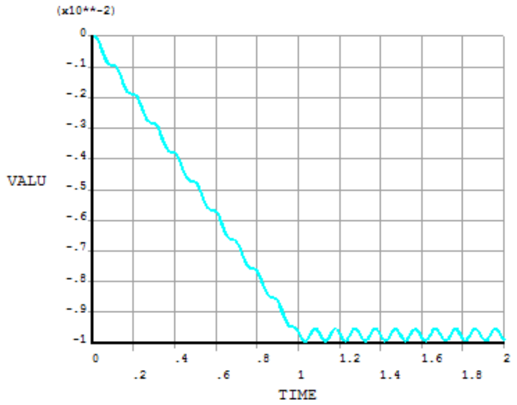

Fig.7 447 node time-displacement curve

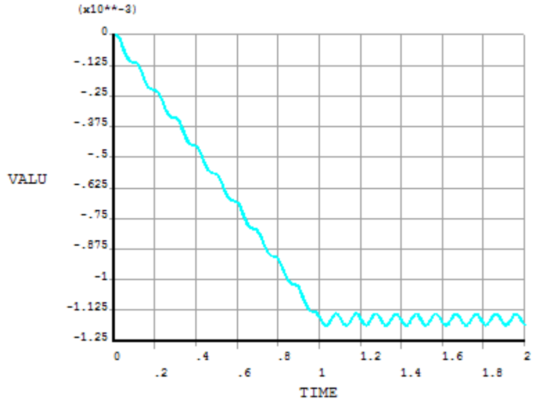

Fig.8 8574 node time-displacement curve

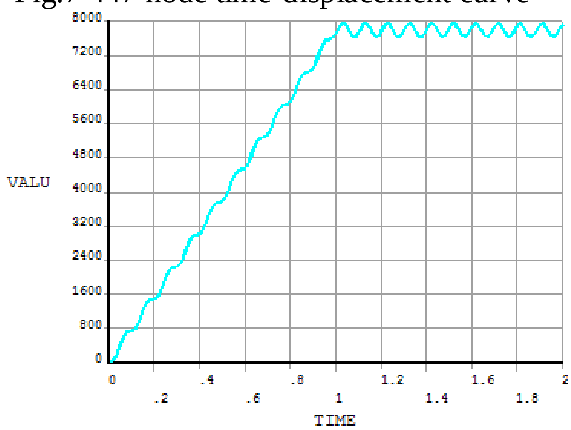

Fig.9 447 node time- stress curve

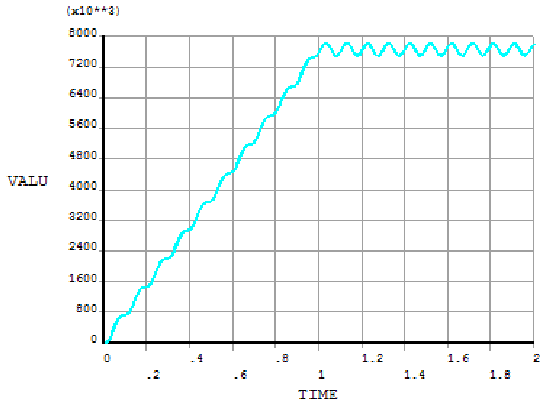

Fig.10 8574 node time- stress curve

Conclusion

(1) Using the transient dynamics analysis of ANSYS (also known as the time history analysis) function, Dynamic response of stacker multi-stage fork in the pickup moment under actual work load was determined.

(2) Through the analysis, in the first step, the maximum deformation is on the front fork; in the second step, the maximum deformation is in the fork between right and left. The maximum vertical displacement of node 447 of upper and node 8574 of middle were at the1s and followed vibration by periodic. The above results can play a guiding role for the optimization and improvement of multi-stage fork structure, and reduce the impact and vibration, increase stability and reliability at the pick up something.

References

[1] M. D. Sheng, Z. Q. Chen, W. H. Fan: submitted to Journal of Hoisting and Conveying Machinery (2009)

[2] Y. Z. Liu, etc. Vibration mechanics, Higher Education Press, Beijing, 1998.

[3] Q.F.J, Mechanical and structural vibration, Tianjin University press, Tianjin, 2006.

[4] Rao S S, the Finite Element Method in Structural Mechanics, Academic Press, 1982.

[5]Dipankar Chakravorty, J.N. Bandyopadhyay, P.K. Sinha: submitted to Journal of Computer structures (1995)

[6]D.Q. Liu: submitted to Journal of Hoisting and Conveying Machinery (2008)