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# The Optimized Design of Excavator Trivet

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**Abstract:** Because the structure of the excavator's trivet is very big, moreover the stress is complex, the working conditions are also very special, so the rigidity is often small in the work process, simultaneously the platform and trivet connect some are easy to present the phenomenon of stress concentrations. If the platform and trivet's design is unreasonable, it will bring very serious consequence. The paper focus on this question and it carries on the optimized design of the trivet. After the improvement, we can obtain the quite ideal structure.

**Keywords:** Electric Shovel, Trivet, Optimized Design

## INTRODUCTION

According to the experience, the effective measures to improve component stiffness is as follows:

- 1)Design reasonably the cross section shape and size of the structure . Under conditions allowed, firstly increase the cross section of the profile size and not the wall thickness.
- 2)Arrange reasonably stiffened plate and rod of the structure. Reinforce plate connection structure of the wall to improve the torsional and flexural rigidity.
- 3)choose reasonably hole size and location. In addition to minimize opening area, but also try to avoid the opening hole near the loading part , also don't make the hole to open under big bending place.
- 4)choose the wall thickness reasonably. the wall thickness should be under the condition of rigidity requirement and the casting process requirement , smaller as far as possible.
- 5)improve the joint stiffness between the components and foundation [1].

Based on the above principle, aiming at the existing problem of tripod, this paper put forward two kinds of solution :

- a)optimize the tripod structure, reduce structural maximum displacement, and eliminate the stress concentration on platform.
- b)use press bar instead of tripod for support, on the premise of install smoothly , remove the weak links on the original tripod .

## THE OPTIMAL DESIGN OF A TRIPOD

Optimized design is a measure of looking for the optimal design scheme [2,3]. refers to a kind of scheme that it can satisfy all the design requirements, and the costs (such as weight, area, volume, stress, etc.)are the smallest.

This article choose the software of ANSYS to optimize the structure of a tripod, the procedureusually includes the following steps:

- 1)generate the loop analysis file;
- 2)Set up the parameterized geometry model (PREP7);
- 3)solve and arithmetic (SOLUTION);
- 4)specify the optimization variables; Extract and specify the state variables and the objective function;
- 5)choose optimization tools or optimization methods;
- 6)specify the loop control optimization mode;
- 7)execute optimization analysis, and check the design sequence results at the end of the optimization process [4,5].

The separate tripod is studied in this paper, and the design variables, state function, the objective function need to do the following options:

- a)The Design variables: B, H, T1, T2, T3, T4, W1, W2 (the tie rod and pillar section size );
- b)The state function; U (the tripod maximum displacement);
- c)The objective function: VOL (the volume of the tripod structure)

Tie rod and the former pillar section are shown in figure 2, the original section sizes are shown in the table below:

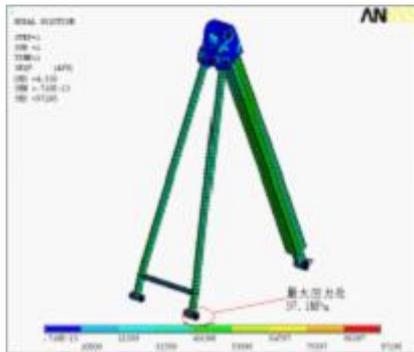
name	B	H	T1	T2	T3	T4	W1	W2
Value(mm)	220	80	20	20	20	20	430	430

A set of optimal data is obtained by optimized as follows in figure 1:

<FEASIBLE>		
U	<SU>	4.0255
B	<DU>	268.07
H	<DU>	113.67
T1	<DU>	39.270
T2	<DU>	39.270
T3	<DU>	38.691
T4	<DU>	38.691
W1	<DU>	429.82
W2	<DU>	427.66
UOL	<OBJ>	0.93650E+09

**Figure 1** The optimization results data

Rebuilt the tripod finite element model by the optimizing section size, and assembly on the platform, to get the whole tripod displacement and the influence on the platform structure. In actual work, when the bucket handle stretch out wholly and the stretching direction is perpendicular to the centerline of the

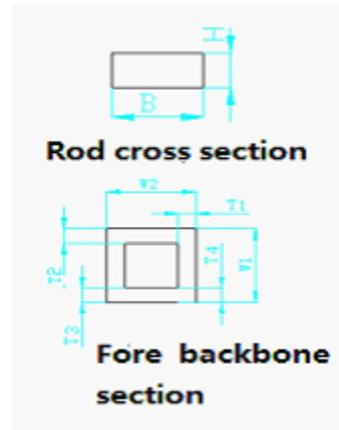


**Figure 3** Tripod stress nephogram

It can be found from the analysis: the improved tripod of maximum displacement is 4.3 mm, it is 11 mm before improvement, achieved the goal of the optimization, but the maximum stress on the front end cover plate including the arc casting part is still big, the value numerical 153 Mpa and 195Mpa respectively, the two values does not meet the requirements.

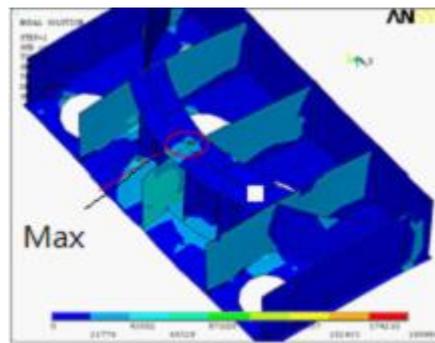
**THE TRIPOD DESIGN IMPROVEMENTS**

This section assumes that improving the weak link at the tripod by changing dual pressure rod support,. The



**Figure 2** Tie rod and front pillar section

movable arm ,the structure is more serious, so in this paper, chose this working condition load applied on the optimized model, it's convenient to be compared. The Improved tripod and the first arc casting parts stress is shown in the figure below:

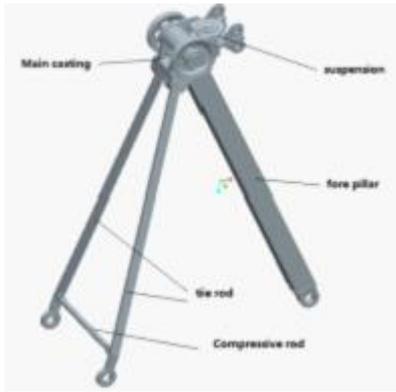


**Figure 4** Arc casting part stress nephogram

reason is as follows:

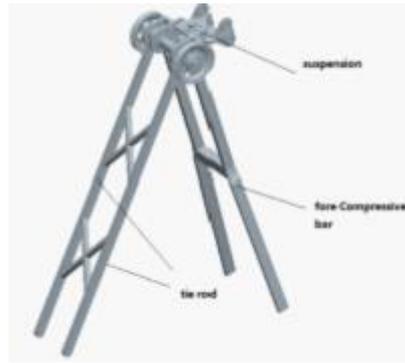
- 1) by changing the relative size, the resistance to deformation ability of the double press bar can be higher than a tripod resistance to deformation ability.
- 2) carefully analysis the relative position relation of members on the platform, be sure that there is enough space to install double push rod hinged support bracket.
- 3) the place- weight box overall weight is big, tie rod hinged position is backward, helps to reduce the weight box displacement.

The tripod original structure is shown in figure 5, dual pressure rod is as shown in figure 6:

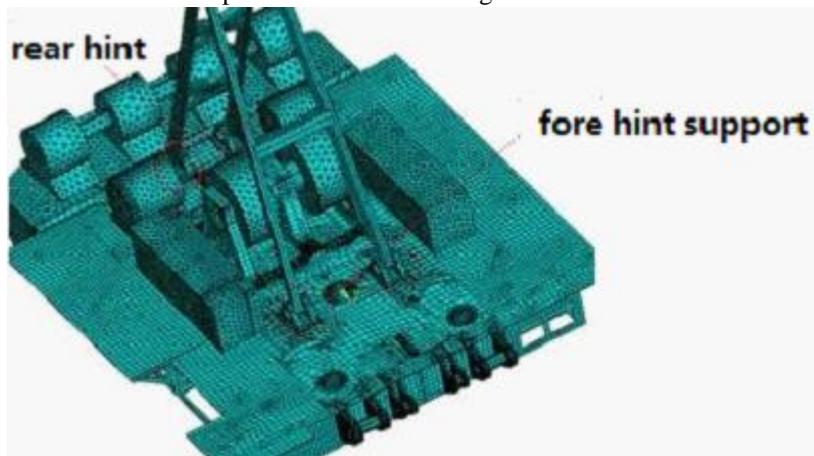


**Figure 5** Tripod structure

Set up the finite element model of the dual pressure rod holder according to the optimized dimension, get the overall displacement and the impact on the

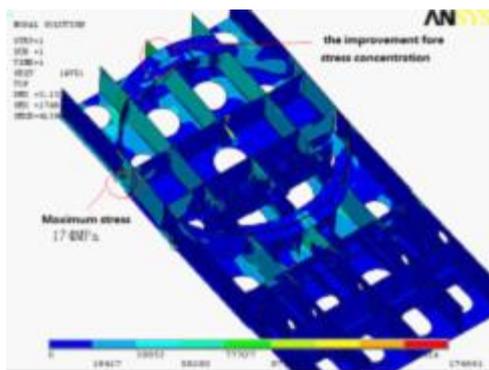


**Figure 6** Double compressive bar bracket platform. The improved dual pressure rod bracket and slewing platform structure diagram are shown in figure 7:

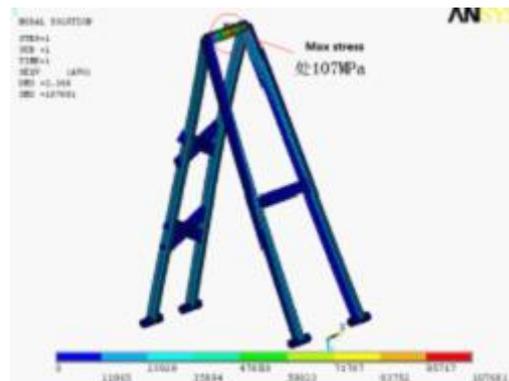


**Figure 7** Dual pressure rod bracket and slewing platform structure

Optimization platform without the cover part and the dual pressure rod stress is as follows:



**Figure 8** Platform without flat part stress nephogram



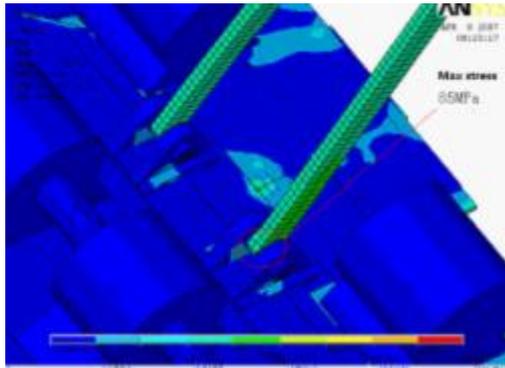
**Figure 9** Dual pressure rod bracket stress nephogram

The Platform maximum stress before improvement without the cover plate on the part is 226 Mpa, the improved is 174 Mpa, the maximal total displacement is 2.56 mm, the improved is 2 mm.

The double press bar support overall maximum displacement is 2.83 mm, its location is at connecting shaft on the top. The tripod resultant displacement prior to the improvement is 11 mm. The reasons of the larger deformation change are two as following:

- a) the improved dual pressure rod bracket have a strong ability to resist deformation.
- b) due to the double press bar supports are next to the weight box, because of the vertical downward, the gravity of the weight box reduces the tie rod stress deformation, the tripod structure with the improvement near the hoisting mechanism, because winding drum force is oblique upward, the force will increase the deformation of a tripod.

The improved Rod and compressive bar force of the bearing diagram are below:



**Figure 10** Back end hinged support stress nephogram

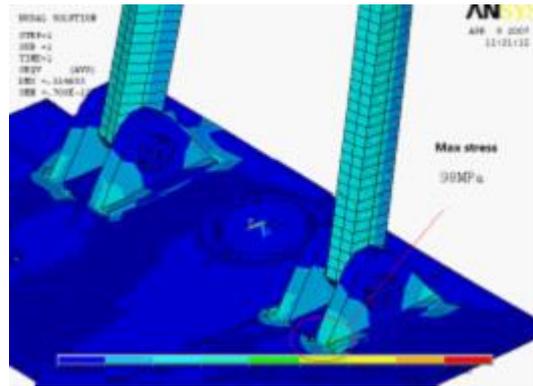
The maximal displacement of Back end hinged joints is 1.8 mm, the maximum stress is 85 Mpa, the improved displacement and stress is more reasonable. The fore end hinged support maximum displacement is 0.8 mm, the maximum stress is 98 Mpa, the improved displacement and stress are more reasonable.

## THE CONCLUSION AND RESEARCH PROSPECT

In this paper, the optimization design employ two solutions ,one is the optimized tripod ,it's the other that double press bar instead of the original structure ,

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**Figure 11** Fore end hinged support stress nephogram

compared these two solutions, the dual pressure rod bracket is far better than to the effect of the optimized tripod structure, according to this conclusion, it will bring great help to optimize structure. Further research work including :

- a) study fatigue failure for the structure analysis.
- b) verify the analysis of structure through the experiment.

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