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Strength Analysis of Main Girder of the Roller Forks

Xiaomei Feng[1, a], Xiubing Duan[1] , Yulan Li[1] , XueCheng Lu[1]

[1] The Department of Military Logistics, The Academy of Military Transportation, Tianjin 300161,China

[a]xiaomeif99@163.com

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Abstract. A new Roller Forks is put forward. And a novel rollers mechanism is used in the forks. As the key component of the forks, the main girder's strength is studied in detail, including its stiffness, maximum stress and the corresponding minimal safety factor. The analysis results show that the girder meets the design requirement.

Introduction

As an important implement, fork-lift trucks are widely used in the depot to lift, stack and convey goods. In order to guarantee the forks expediently insert the base of the goods when fork-lift trucks lift goods, generally, pallets are widely used during forking goods. For example, some pallets are placed under the goods, and some others are mounted on the wrapping box of the goods. But problems exist in using of the pallets. Such as, deposited space's minishing, high cost and high mangled and maintenance cost. So the macro pallet increases the production cost, use cost, deposited and conveyance cost [1-3].

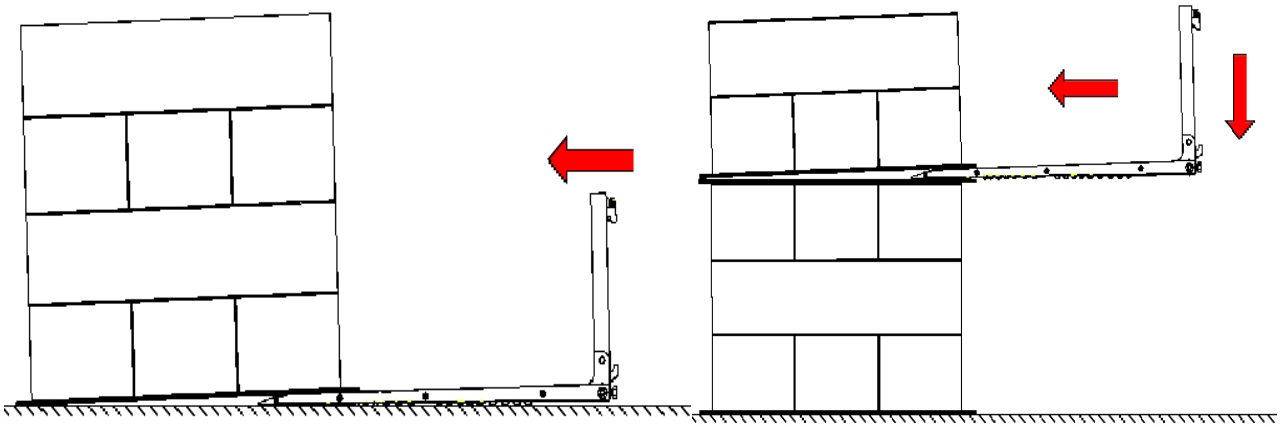


Fig.1 Lifting up loads with Roller Forks

As the important mechanism, forks play a key role in the fork-lift trucks and make it can fork, push, draw and lateral move the goods. In order to solve the limits of the pallets' using, Roller Forks used for fork-lift trucks are put forward. As shown in Fig1, The Roller Forks offer the option for lifting, separating and replacing goods which are placed on a slip sheet. At the same time the Roller Forks can be inserted into pallets in order to lift and move goods [4].

As an important component in the Roller Forks, the main girder is the main load supported part [5], so the girder's strength is studied in detail.

Structure of Roller Forks

As shown in Fig.2, Roller Forks used for fork-lift trucks are equipped with a double roller system, aimed at lifting products onto a slip-sheet. Still, Roller Forks are narrow enough to be pushed under a pallet. In this way, the forks can be used easily when operating a mixed logistical system, which handles both pallets and slip-sheets.

Fig.2 Roller Forks

Roller Forks function without hydraulics, so that there are no requirements in this field as far as the fork-lift or the lifter are concerned. That is to say, the Roller Forks do not make use of hydraulics or electronics, and because of this no requirements to the fork-lift truck or lifter exist in this field [4].

And Roller Forks are designed in such a way that minimum maintenance is necessary, which allows them to attain the longest possible life-span. To achieve this it is really important that the maintenance is performed according to the instructions of the manufacturer.

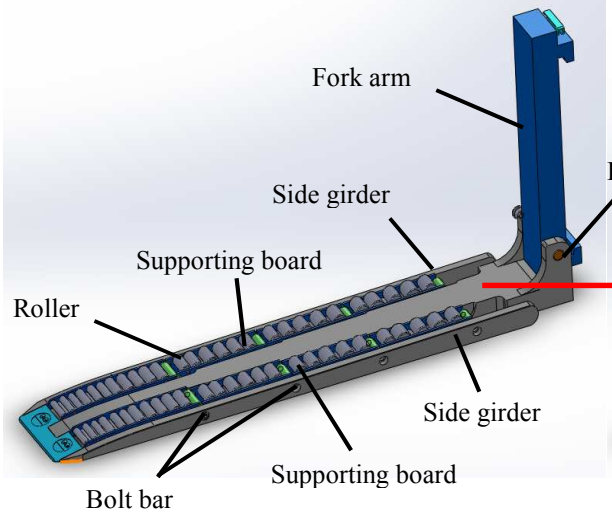


Fig.3 Roller Forks model

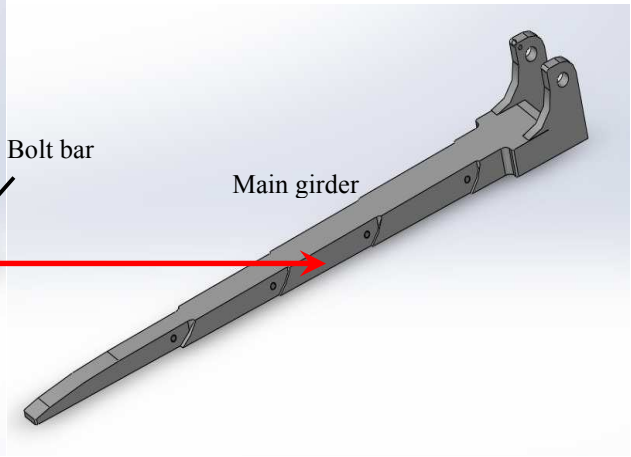


Fig.4 Main girder model

As shown in Fig.3, Roller Fork is mainly consists of main girder, fork arm, side girder, supporting board, rollers and bolt bars. Main girder is mounted on the fork arm through bolt bar, can run with the bolt bar in 90º. The side girders and supporting boards connect main girder by bolt bars. Rollers are mounted between the main girder and the side girders through bolt bars, and the rollers can run around the bolt bars.

As the main study object, the main girder model is shown in Fig.4.

The Finite Element Model of Main girder

Based on the model of main girder in Fig.4, by gridding partition, as shown in Fig.5 is the finite element model of main girder. And the casting steel is selected as the main girder's material [6].

The Statics Analysis of Main girder

The Distortion of the Main Girder Under Load. In order to study the distortion and stress of the main girder under the load, the bolt bar holes are constrained. And the load of 500kg is forced on the top surface of the main girder.

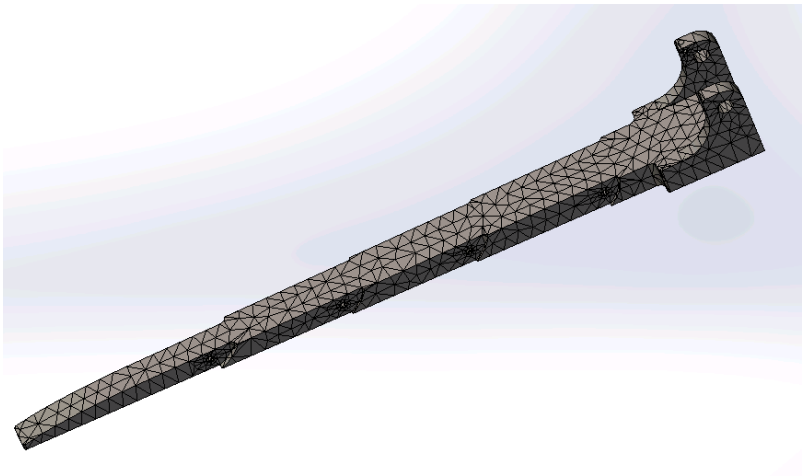
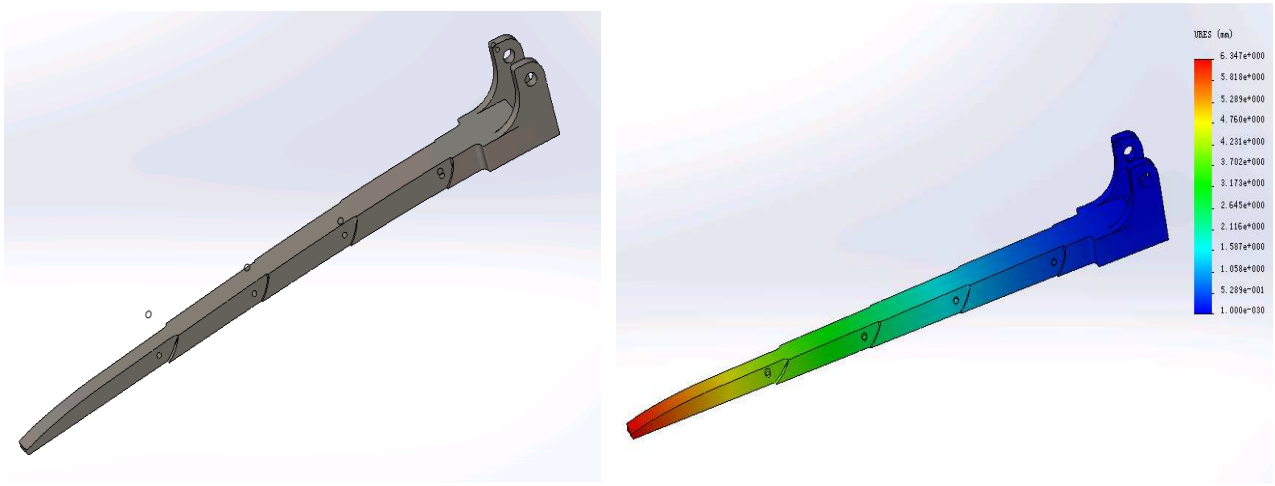


Fig.5 Main girder FEM

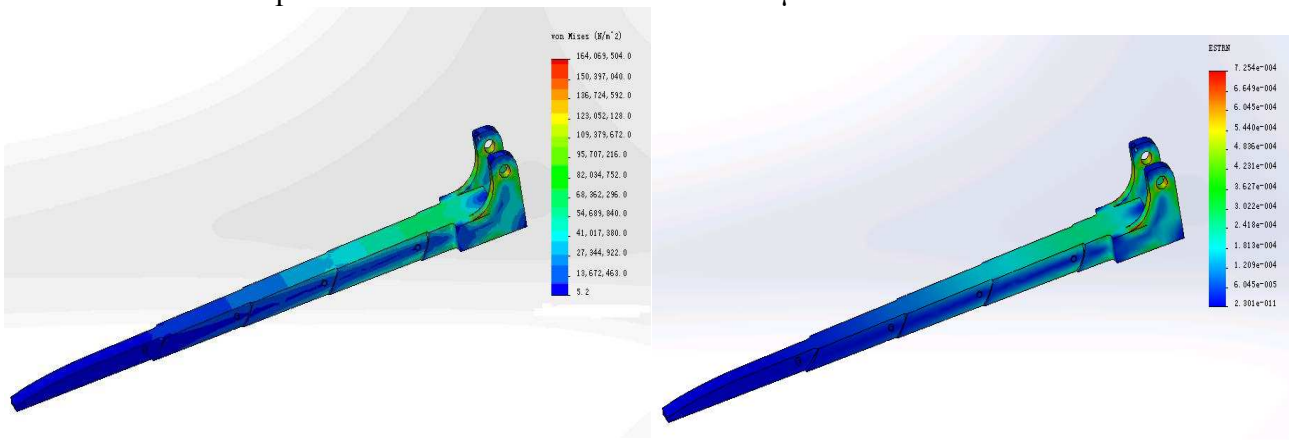
As shown in Fig.6 are the distortion and displacement diagrams of the main girder.



a) Distortion diagram of the main girder b) Displacement diagram r of the main girder

Fig.6 Distortion of the main girder

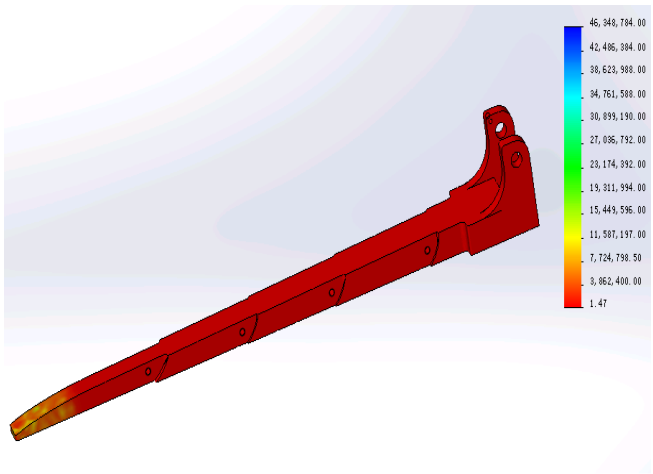
According to Fig.6, under the 500kg load, the downbent distortion occurs on the outboard port of the main girder. Based on the whole distortion trend, the distortion is largen gradually from the fork arm side to outboard port. And the max distortion is 6.34695μm.



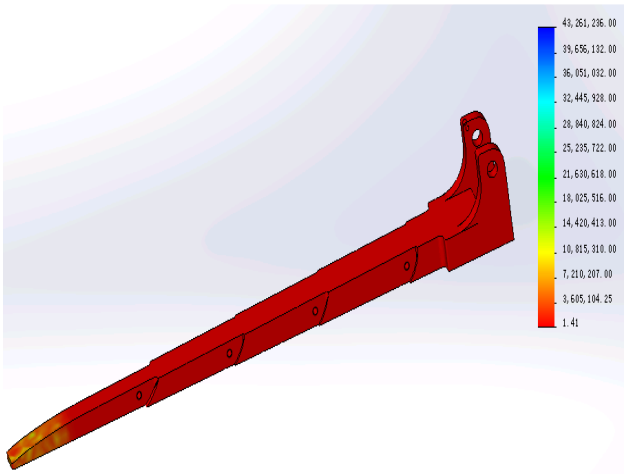
a) Stress diagram of the main girder b) Strain diagram of the main girder

Fig.7 Stress of the main girder

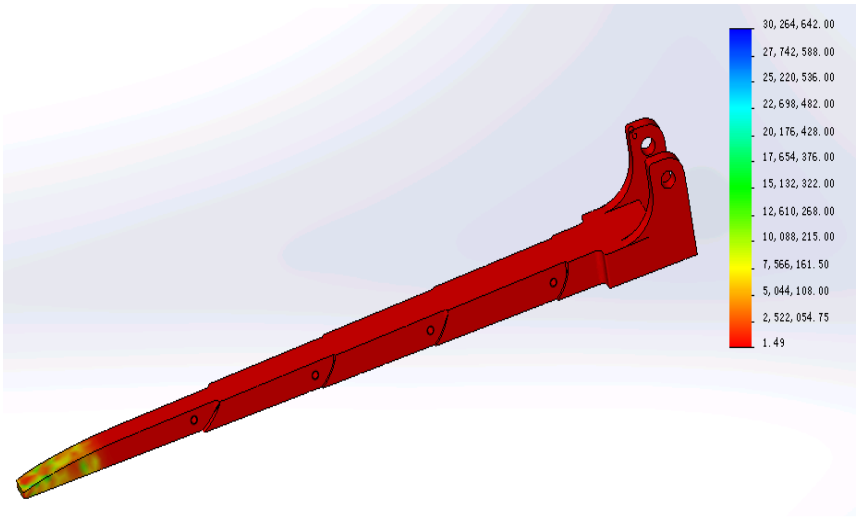
The Stress of the Main Girder Under Load. As shown in Fig.7 are the stress and strain diagrams of the main girder. According to Fig.7, contrary to the distortion, the stress is largen gradually from outboard port to the fork arm side. Also stress at the fork arm side of the main girder is the largest, and the max stress is 164.07Mpa.



a) Safety factor under max stress



b) Safety factor under max shearing strength



c) Safety factor under normal stress

Fig.8 Safety factor of the main girder

The Minimal Safety Factor of the Main Girder Under Load. As shown in Fig.8, corresponding safety factor can be obtained. According to Fig.8, the minimal safety factor of the main girder under max stress is 1.5. The minimal safety factor of the main girder under max shearing strength is 1.4. And The minimal safety factor of the main girder under max normal stress is 1.5.

Conclusions

Based on the software SOLIDWORKS, the FEA model of Roller Forks with novel rollers mechanism is founded. As a key component of the Roller Forks, the main girder static characteristic is the emphases in studying. Based on the main girder FEA model, its distortion and stress under the load is analyzed. Analysis results show that its stress less than its allowable stress value.

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