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# Finite Element Static Analysis of Male and Female Links of a Chain Drive

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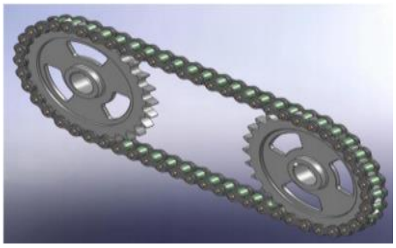
## ABSTRACT

The chain drive consists of endless chain wrapped around two sprockets and can be defined as a series of links male and female links which connected by pin joints. This is special type of power train most commonly used in bicycles, automobiles, industrial equipment and heavy earth moving equipment. Of two sprockets, one sprocket drives the systems called as power wheel and other called pinion. Due to this motion some tension develops in the chain. Due to the action of tension some stresses will be developed inside the chain links. The main aim of the paper is to find the stress distribution in male and female links and to find which link is weaker and ratio of maximum stress in male link to female link.
**Keywords:** CMOS, Bi-Triggering Method, nMOS, pMOS, Bi-Trig, BTC, HOM, FOP, VDD, BTC, RCA

## I. INTRODUCTION

The chain drive consists of endless chain wrapped around two sprockets consists of series of links of different cross sections are called the male link and other called female link. The outer link which sits into the other inner link is called male link and the inner link is called female link. These links are of different cross section, so the stress distribution in the both links will not be same and will have different value. The main aim of the work is to calculate the maximum stress in each of links and find which link fails first and the ratio of maximum stress in male link to female link. Modelling of links is done in Solid Works and further analysed using Ansys.



## II. METHODS AND MATERIAL

### A. Design Specification:

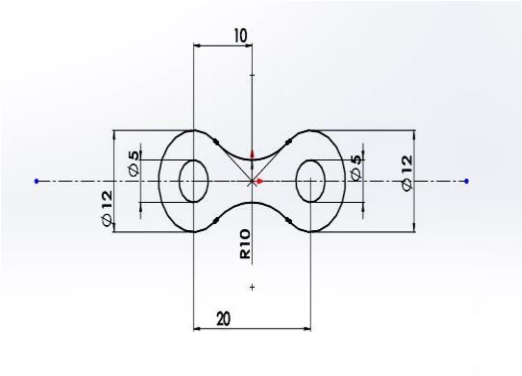
Chain type: 1 Strand roller chain.
Chain material: Stainless steel
Application: Bicycle
Net tension in chain: 250 N.
Load on single element: 125 N.
Properties of stainless steel material:
Tensile yield strength = 207 MPa
Ultimate tensile strength = 586 MPa
Young's modulus = 193 GPa

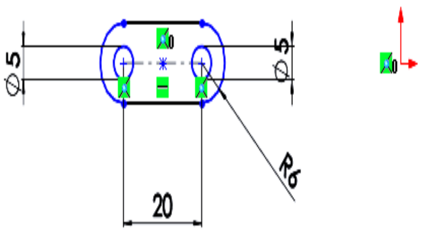
**Design specification of female link:**
Centre distance: 20mm.
Tip Radius: 6mm.
Roller diameter: 5mm.

**Design specification of male link:**
Centre distance: 20mm.
Tip radius: 6mm.
Roller diameter: 5mm.

## B. Modeling:

### Geometry:




Modelling of the chain was carried out in Solid Works software.

**Figure 1.** Model of Male Link

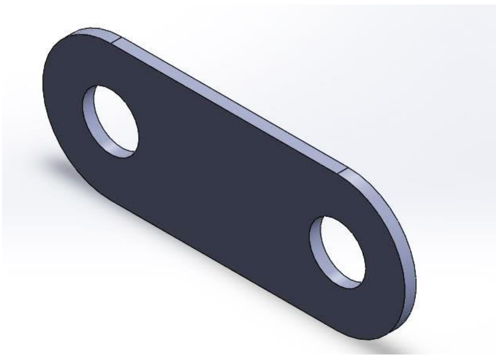


**Figure 2.** Model of female link

### Load Determination:

The assumed tension in the chain is 250 N which can pull a mass of 250 kg on a rough terrain of coefficient of friction 0.1 T=umg
U=0.1
M=250 kg
G=10 m/s2
Therefore  T=250 N.
This tensile force will be laid on the chain which will be distributed across the chain here in our design we have taken only one section of chain drive so the force on each element will be 125N.
(The load/tension is calculated assuming that the chain is used to pull a mass of 250 Kg ).

### Meshing and Loading:

Fine mesh is selected and aload of 125N is applied on the links

**Figure 3.** Meshing of male link.

**Figure 4.** Meshing of female link

| Details of "male link meshing" | |
|---|---|
| Span Angle Center | Fine |
| Minimum Edge Length | 0.50 mm |
| + Inflation | |
| − Patch Conforming Options | |
| Triangle Surface Mesher | Program Controlled |
| − Patch Independent Options | |
| Topology Checking | Yes |
| + Advanced | |
| + Defeaturing | |
| − Statistics | |
| Nodes | 18699 |
| Elements | 3486 |

**Figure 5.** Male link details

| Details of "female link meshing" | |
|---|---|
| Span Angle Center | Fine |
| Minimum Edge Length | 1.0 mm |
| + Inflation | |
| − Patch Conforming Options | |
| Triangle Surface Mesher | Program Controlled |
| − Patch Independent Options | |
| Topology Checking | Yes |
| + Advanced | |
| + Defeaturing | |
| − Statistics | |
| Nodes | 21419 |
| Elements | 4041 |

**Figure 6.** Female link details

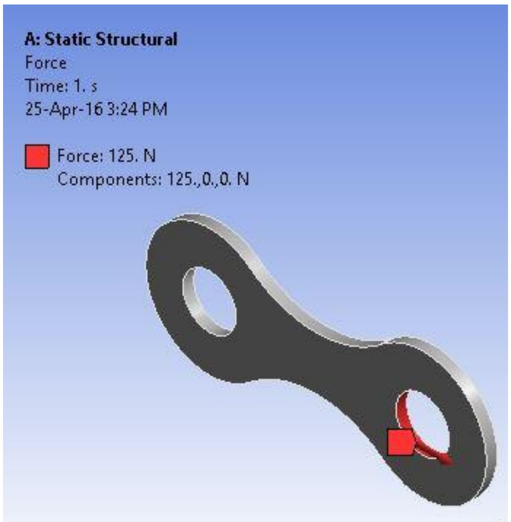



**Figure 7.** Load on male link.

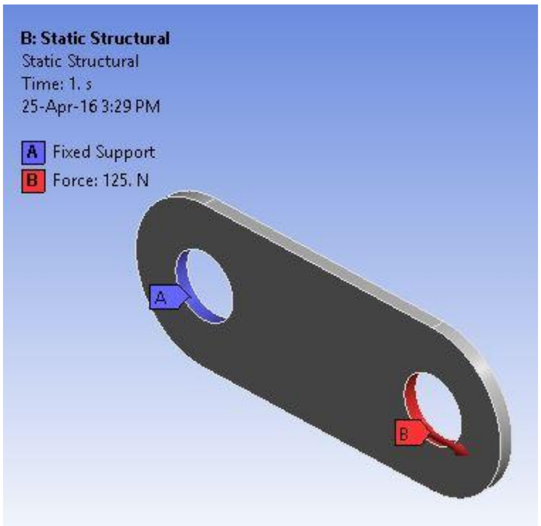



**Figure** 8. Load on female link.

## III. RESULTS AND DISCUSSION

**Analysis:**

**Male Link Analysis:**

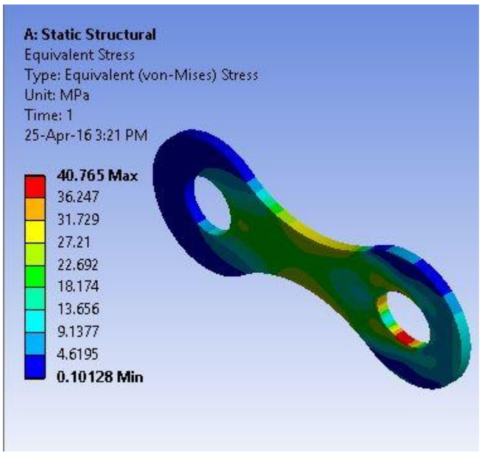



**Figure** 9. Stress distribution of male link

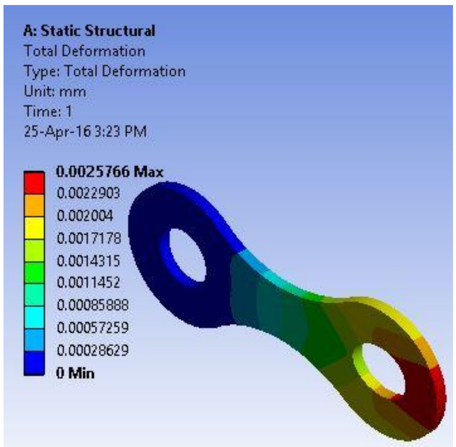



**Figure** 10. Deformation of male link

**Female Link Analysis:**

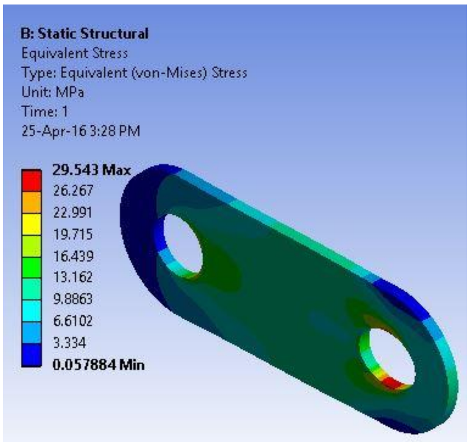



**Figure 11.** Stress distribution of female link

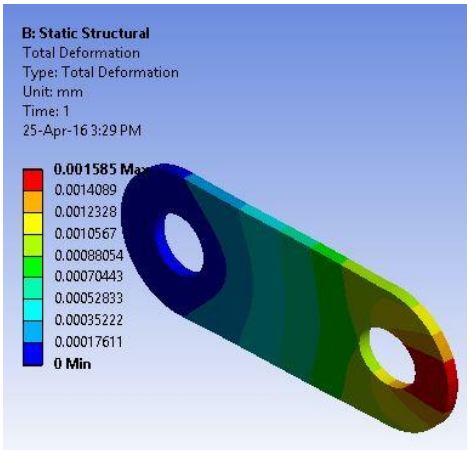



**Figure 12.** Deformation of female link

**Results :**

| Sno | Link | No of elements | No of nodes | Maximum stress (MPA) | Maximum deformation (mm) |
|---|---|---|---|---|---|
| 1. | Male | 18699 | 3486 | 40.765 | 0.00257 |
| 2. | Female | 21419 | 4041 | 29.543 | 0.00158 |

## IV. CONCLUSION

Form the above finite element analysis the maximum stress that will act on male link is 40.765 MPa and on that of female link is 29.543 MPa .which is much below when compared to male link. The deformation is more in male link under assumed test conditions. The ratio of maximum stress in male link to that of female link is 1.379 (>1) so the chain may fail due to maximum induced stress in male link first so we have to design the chain drive based on male link geometry. To avoid this problem modern chains are designed with same geometry for both the links.

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