# Design & Modification of Aero-Shaft From Pneumatic to Mechanical

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**Abstract -** *This is a research project which is mainly concentrated on modification of aero-shaft. The aero-shaft is also called as mandrel. Here this type of mandrel is used for rewinding of the paper coils. The previous model of aero-shaft is pneumatically operated in which as the pneumatic air enters the mandrel the outer layer of the mandrel expands and it holds the inner layer of the paper coil. Here in this project we are modifying it from pneumatic to mechanically operated mandrel by adding lead screw and wedges for the operation of the mandrel.By converting it from pneumatic to mechanically operated we can reduce the maintenance cost of the mandrel. The life of the mandrel will be increased*

***Key Words*: Aero-Shaft, Mandrel, Pneumatically Operated, Mechanically Operated, Lead Screw, Wedges.., Etc**

## 1. INTRODUCTION

Salem steel plant is the youngest unit in SAIL. The products manufactured are sheets and coils of stainless steel. The steel coil after the reduction in the thickness winds up in coils. The interleaving papers are used in between the steel strips and it is provided from the separate paper mandrel. The loading and unloading of the paper sleeve after the paper rolls roll fully over the steel sheets play a very important role in the production of steel strips. As the current design for the paper mandrel takes a long time to interchange the paper sleeves our idea is to design a mechanical type of paper mandrel that decrease the time for this replacement significantly.

The aim of our project is to decrease the time taken by the bellow type mandrel for loading and unloading of interleaving paper sleeve which winds up simultaneously with the steel sheets in the Cold Rolling Mill (CRM).It also eliminates the various drawbacks of existing type of mandrel (i.e.) bellow type mandrel which eliminates the drawbacks like leakage of compressed air, lack of gripping the larger diameter paper sleeve, damage caused to grippers etc.Hence the use of mechanical type of paper mandrel for the replacement of the paper sleeves is an easy and effective alternate to the existing model.

## 2. DESIGN METHODOLOGY

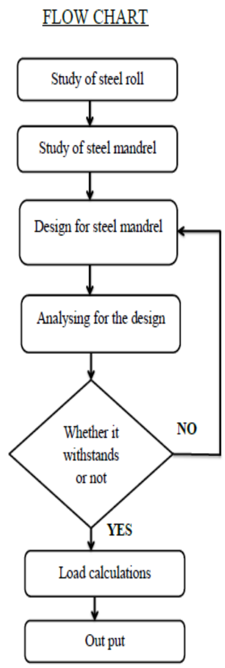


**Fig -1**: Flow Chart for Methodology

- The study of the paper roll is carried and the detailed study about the paper weights are been carried.
- Study of the existing type aero shaft is carried and reviewing it with the remodeled type.
- Now the design for the mechanically operated aero shaft is carried using the NX-CAD software
- After the design for the aero shaft is completed now the analysis is also been carried for the aero shaft.

- Now during the analysis of aero shaft we refer that whether it with stands the load applied to it or not.
- If the shafts else not withstands the load then it is again sent back to design step and analysis carried. Until it with stands the load and satisfies.
- After the analysis is completed the analysis report is been generated and calculation are also been acts generated.
- Now the output results are been referred with the previous reports.

## 3. EXISTING MODAL

The existing type of paper mandrel is the pneumatic type in which pressurized air is used to grip the object. It consists of solid shaft in which various slots are made and inside of which there is a air bellow.

When compressed air is given to the bellows provided inside the solid shaft of mandrel, it expands and due to which slots come out to hold the paper roll. Thus it grips the paper roll and prevents the relative motion between the paper roll and mandrel.

The air is filled in the bellows to hold the paper rolls. Whenever the air is leaked, the mandrel loses the grip over the paper roll, which makes the misalignment of the paper and disturbs the overall process, sometimes the paper will also tear due to misalignment.

One of the major problems is the varying diameter of the paper sleeve. The paper rolls imported, varies in the diameter of the paper sleeve, which varies from 110mm diameter to 120mm diameter. But already existing sleeve can be expanded maximum up to 115mm. so, it is unable to grip if diameter changes. Third problem found is the puncture of the bellows. Due to which whole setup has to be removed to change the bellows. In fiber optics, an optical fiber is often wrapped around a mandrel to after the light traveling in the fiber.

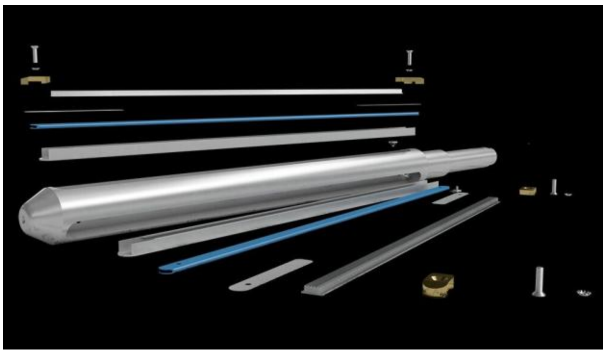

**Fig -2**: Existing System Diagram

## 4. PROPOSED SYSTEM

Here in this project we are modifying it from pneumatic to mechanically operated mandrel by adding lead screw and wedges for the operation of the mandrel. In this type we use lead screw to hold the inner surface of the sleeve which is used for the rewinding of the paper coil

### 4.1 Working

The paper roll is brought through the crane and it is inserted into the mandrel. The center line of the paper roll is made to align with the center line of the aero-shaft. Now the loaded paper coil is been locked through the mandrel. As the lead screw is rotated the wedge which is fixed to the lead screw also moves in the linear direction. Here the rotary motion is converted into linear motion. The slider which is connected to the wedge also moves accordingly with the wedge and the metallic gripper which is above the slider also moves. After the coiling is done the paper coil is removed from the aero-shaft by unlocking it.

### 4.2 Parts Description

The various parts used in the mechanical type of paper mandrel are as follows

- Flange coupling
- Bearings
- Hollow shafts
- Screw rod
- Frame
- Box nut& Guide bolt

### 4.3 Screw

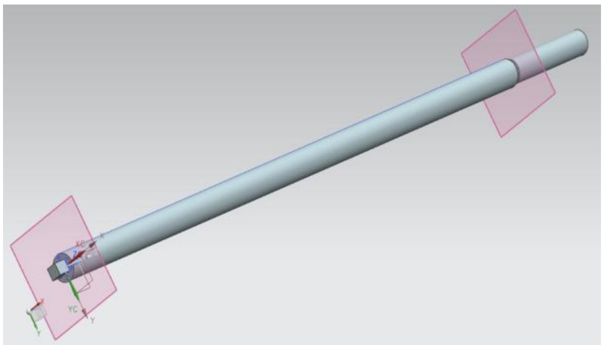

**Fig -3**: Screw Diagram

The screw is used to transfer the power given from one end evenly through the entire shaft.

### 4.4 Flange

The flange here acts as the bolt to the lead screw to rotate the screw freely through the body.

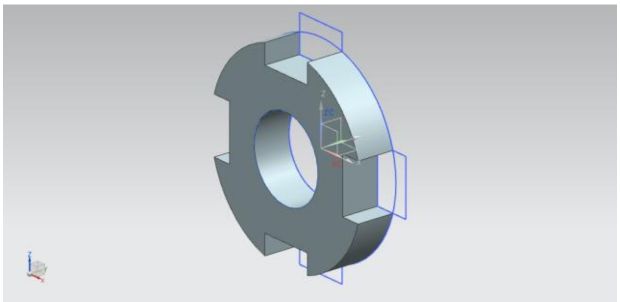

**Fig -4**: Flange Diagram

### 4.5 Wedge

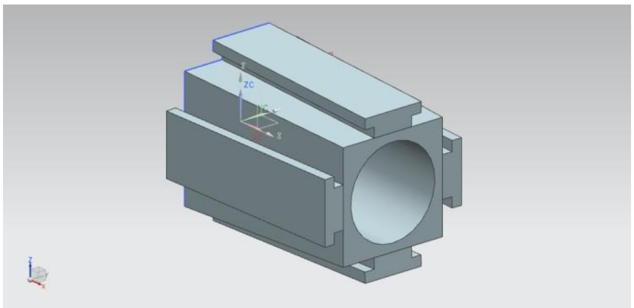

**Fig -5**: Wedge Diagram

The wedge is used for transferring the linear motion from horizontal to vertical.

### 4.6 Slider

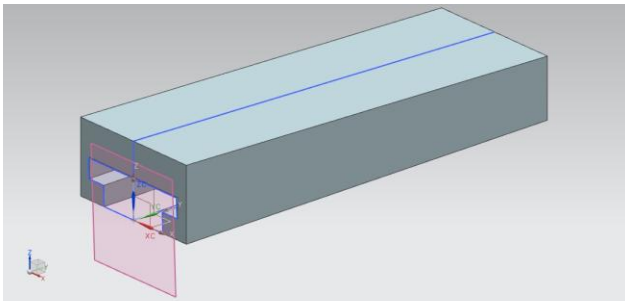

**Fig -6**: Slider Diagram

The slider is placed above the wedge to adjust movement of the metal strip.

### 4.7 Metal Strip

Metal strip or it is also called as gripper which is used for holding the inner sleeve in the paper coil

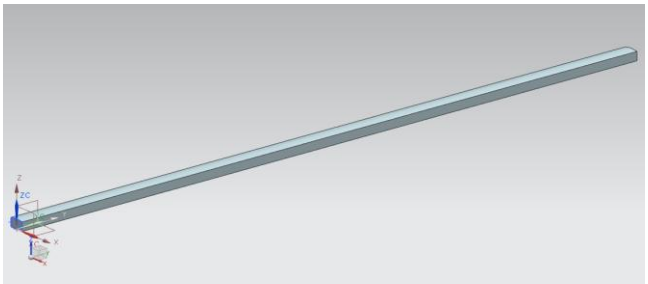

**Fig -7**: Metal Strip Diagram

### 4.8 Outer Shell

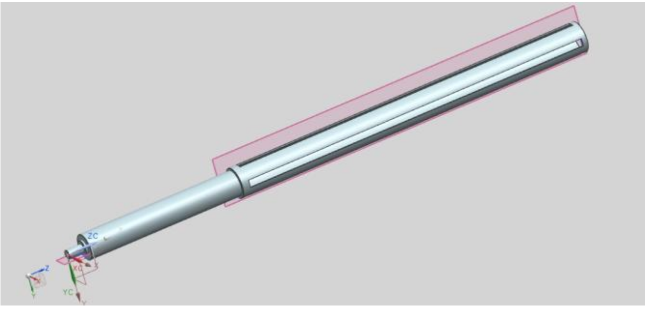

**Fig -8**: Outer Shell Diagram

The outer shell is the major component in the aero shaft in which the entire assembly of the components are been placed

### 4.9 Screw & Wedge Assembly

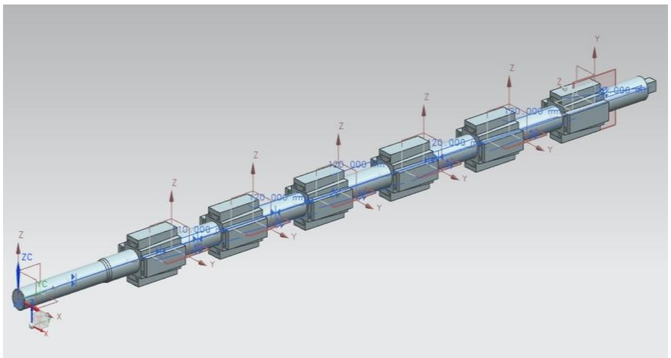

**Fig -9**: Screw & Wedge Assembly Diagram

The above figure represents the assembly of the wedge & slider to the lead screw

### 4.10 Entire Mandrel Assembly

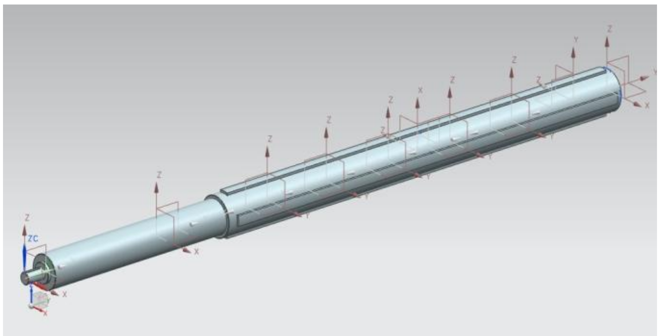

**Fig -10**: Entire Mandrel Assembly Diagram

The above figure shows the assembled diagram of the entire aero-shaft

### 4.11 Explored View of Entire Mandrel Assembly

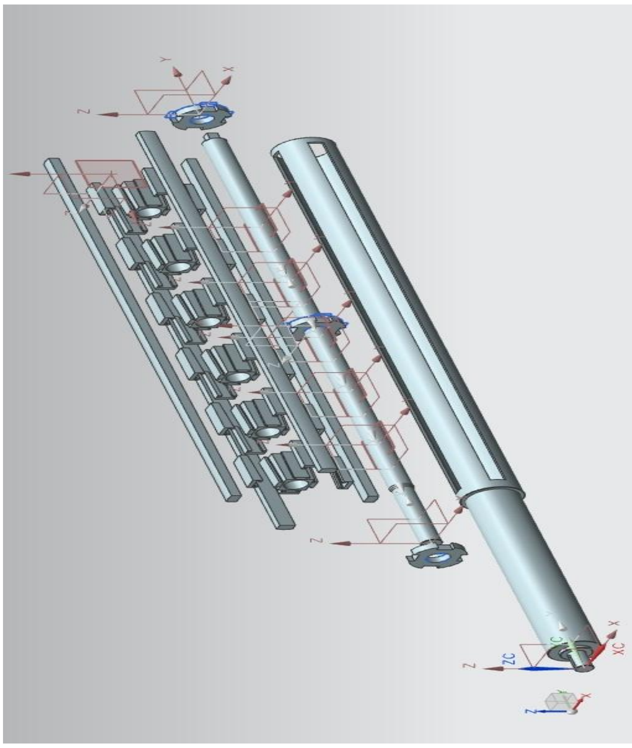

**Fig -11**: Explored View - Entire Mandrel Assembly

## 5. RESULTS & DISCUSSIONS

**Author** : Mention Above
**Company** : Siemens PLM Software Inc
**Date** : 18-03-2016
**Software Used** : NX 7.5.0.32

### 5.1 Displacement Result

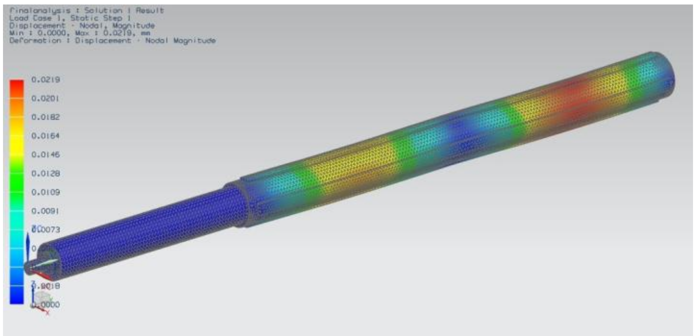

**Fig -12**: Displacement Result

Minimum displacement – 0.000mm
Maximum displacement – 0.0219mm

### 5.2 Stress Result

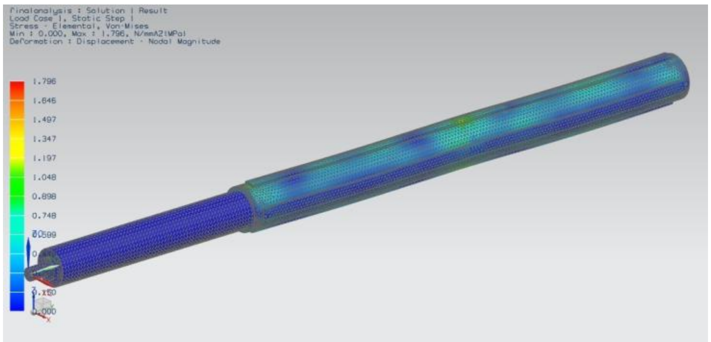

**Fig -13**: Stress Result

Von-mises minimum – 0.000 N/mm$^2$
Von-mises maximum – 1.796 N/mm$^2$

### 5.3 Strain Result

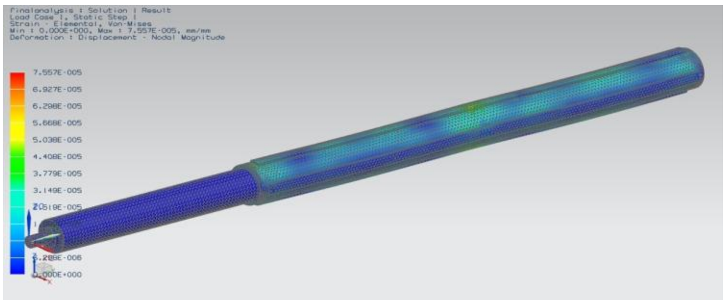

**Fig -14**: Strain Result

Von-mises minimum – 0.000E$^{+000}$
Von-mises maximum – 7.557E$^{-005}$

### 5.4 Reaction Force Result

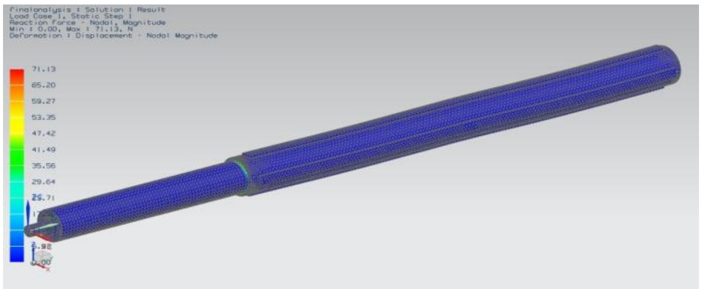

**Fig -15**: Reaction Force Result

Reaction force minimum – 0.000 N
Reaction force maximum – 71.13 N

**Table -1:** Simulation Final Report

| Load Case 1 : Number of Iterations = 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Displacement (mm) | | | | Stress (mN/mm^2(kPa)) | | | |
| | X | Y | Z | Magnitude | Von-Misses | Min Principal | Max Principal | Max Shear |
| Static Step 1 | | | | | | | | |
| Max | 6.730e-004 | 4.969e-003 | 1.195e-003 | 2.188e-002 | 1.533e+003 | 4.748e+002 | 1.965e+003 | 8.273e+002 |
| Min | -6.798e-004 | -5.054e-003 | -2.187e-002 | 0.000e+000 | 0.000e+000 | -2.176e+003 | -6.014e+002 | 0.000e+000 |

## 6. CONCLUSIONS

Thus the mechanical type of paper mandrel is designed and fabricated to replace the pneumatic type of paper mandrel. Which eliminates the various disadvantages of the pneumatic type and there by reduces the loading and unloading time of the paper sleeve? The function of the mechanical type of paper mandrel is found to be very easy and effective. It saves both man power as well as the time for charging paper sleeve.

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