Static & Dynamic Analysis of Sugarcane Trolley Axle

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Abstract- *In the present market scenario, cost reduction technique is playing a signified role to meet the competition in the market. Weight reduction and simplicity in design are application of industrial engineering etc. are used as sources of technique. Various components or products used in rural areas are mostly manufactured in small scale industries such as farming machinery, thrashers, tractor trolleys etc. It has been observed that these rural products are not properly designed. Tractor trolleys are manufactured in small to moderate scale industries. In this paper, survey is made on sugarcane tractor trolley, during survey it is found that most of axles having bending, deformation, weight, strength problems, and common problem are bending. In this paper, dynamic analysis is done on axle by finite element analysis using ansys16 for checking bending, deformations and weight optimization by changing existing design for SAE1020.*

I. INTRODUCTION

Based on finite element analysis, redesign of axle was carried out for reducing the cost and weight and maintains the mechanical strength with easy manufacturability and cost reduction. Results of static, modal and transient analysis of proposed axle under loading due to modified combine showed that the proposed model is suitable to install on trolley.

In this paper we tried to optimize the hollow axle for the ultimate value so that the strength should be maintained with the reduction in cost and weight and we find the weight is reduce 40 to 60 %. The design is optimized based on the manufacturing cost of the axle. The failure analysis is performed on the axle of trolley used in agricultural area. These results provide a technical basis to prevent future damage to the location axle.

In the global competition, it is very important for the manufacturer to bring new product designs to market at a faster rate & also at reduced cost. Front axle beam is one of the major parts of vehicle suspension system; it takes about 35-40% of total vehicle weight. Optimization of axle beam is necessary to improve strength to weight ratio for a given factor of safety without altering any assembly parameters. The main purpose of the trolley is to provide ahassle-free mode of transporting firewood. The existing designs of trolleys are enormous due to the fact that they need to carry loads of different sizes. It is a known fact, that the mountain dwellers have great skill in stacking up the firewood collected. The objective of this paper to optimize the axle design using finite element analysis method and to validate the design. The main purpose is to reduce the weight of the axle as the axle is the only component who bears the whole load plus the weight of the trolley and then it transfer to the wheel.

In the present market scenario, cost reduction technique is playing a signified role to meet the competition in the market. Weight reduction and simplicity in design are application of industrial engineering etc. are used as sources of technique. Various components or products used in rural areas are mostly manufactured in small scale industries such as farming machinery, thrashers, tractor trolleys etc. It has been observed that these rural products are not properly designed. Tractor trolleys are manufactured in small to moderate scale industries. Though tractor trolleys are manufactured of various capacities by various industries, still there is a large variation in manufacturing methods, component design etc. The urgent issues for industrial companies today are how to reduce the time and cost required for developing a new product. Accordingly, they have tried to use the computer's vast memory capacity, fast processing speed, and user-friendly interactive graphics capability to automate and tie together otherwise cumbersome and separate engineering or production tasks, thus reducing the time and cost of product development and production.

II. OBJECTIVES

1. To find bending stress and strain of sugarcane trolley axle, to overcome the axle bending problem by dynamic analysis
2. To check strength of axle by dynamic analysis
3. To optimize the weight by modifying the design

III. METHODOLOGY

3.1 Dynamic Analysis of Axle with 3 slots:

- **Material Properties**

Material	**SAE1020**
1. Young's modulus	2.05e+005 Mpa
2. Poisson's Ratio	0.3
3. Density	7.87e-006kg/mm3

4.Tensile yield strength	350 Mpa
5.Tensile ultimate strength	420 Mpa

1. CAD Model

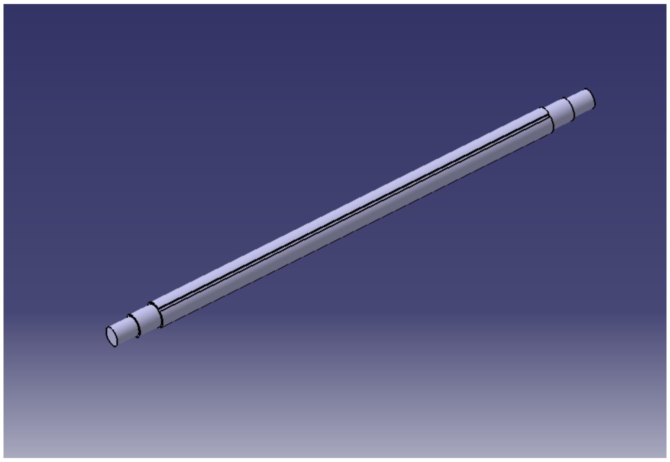
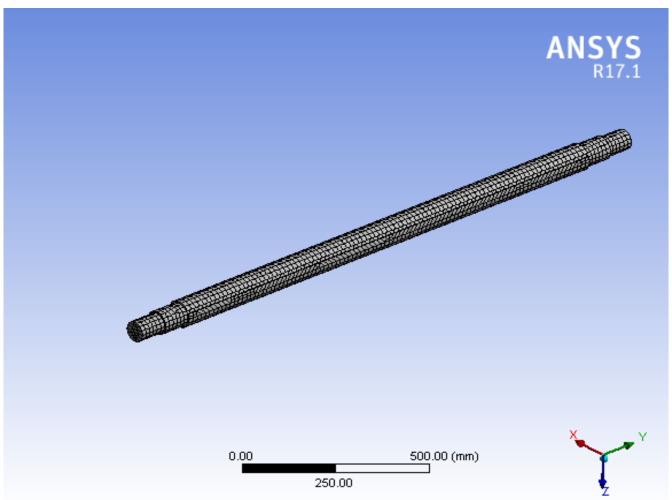


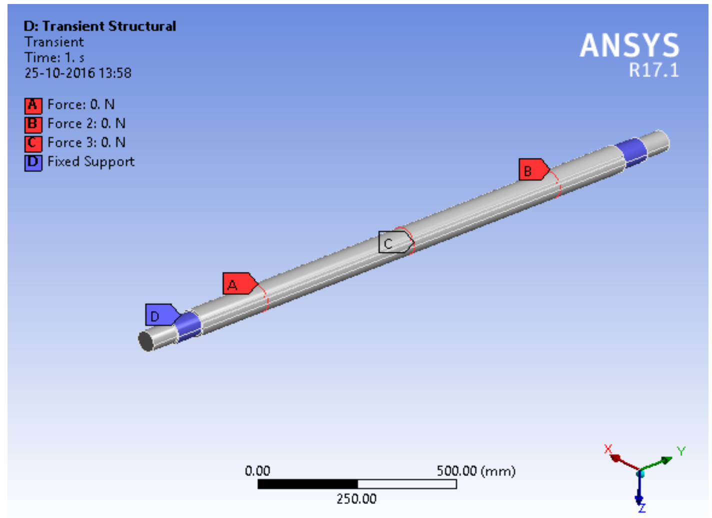
Fig. CAD model of axle with 3 slots

2. Meshing



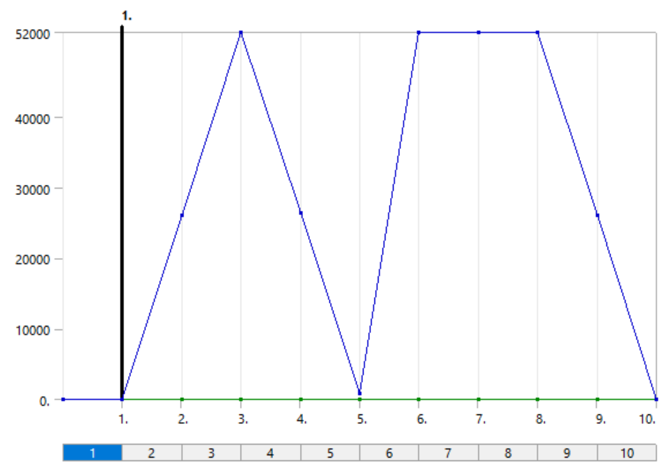
No. of Nodes	28775
No. of Elements	7813

3. Boundary Conditions



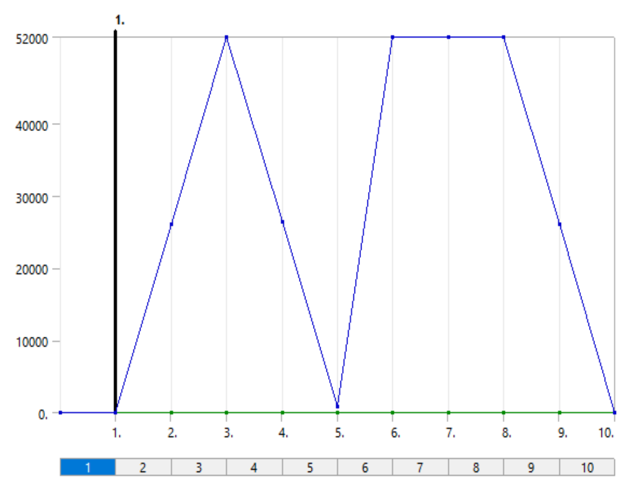
Force applied for Dynamic Condition

1. Force A



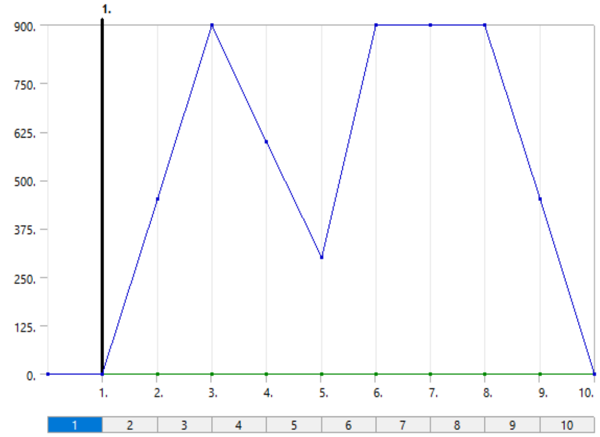
Force applied at point A

2. Force B



Force applied at point B

3. Force C

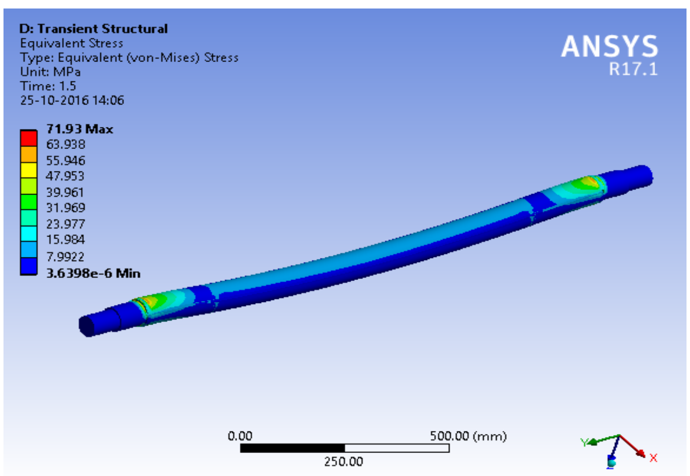


Force applied at point C

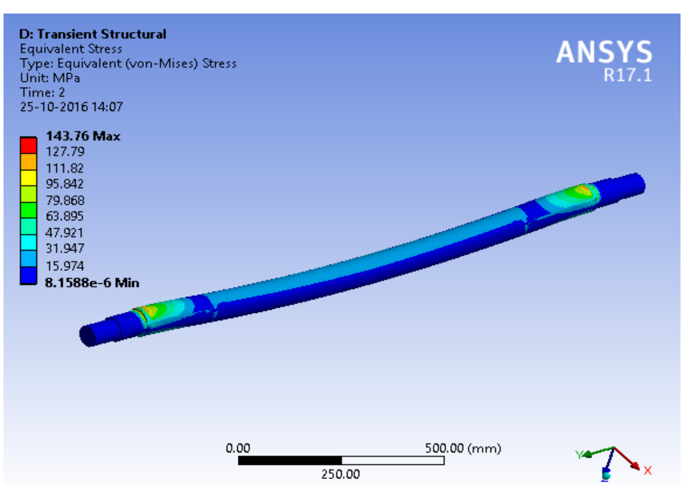
4. Results

a. Von-Mises Stress

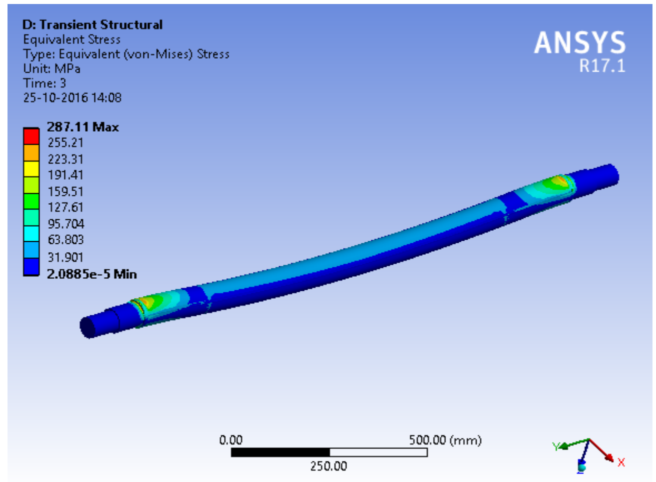
At t = 1.5



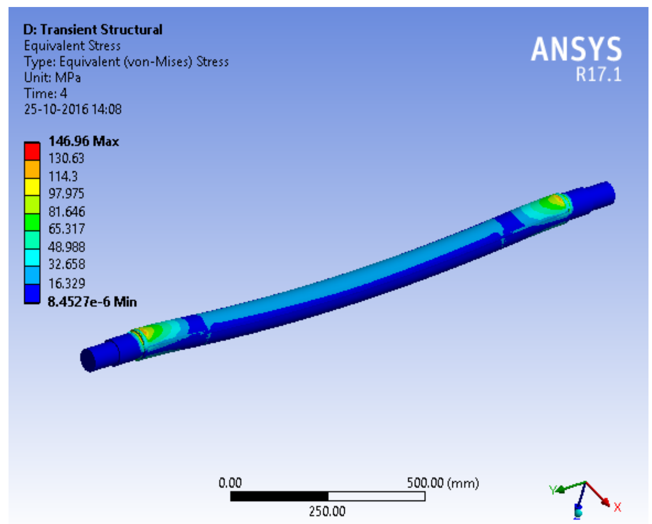
At t=2



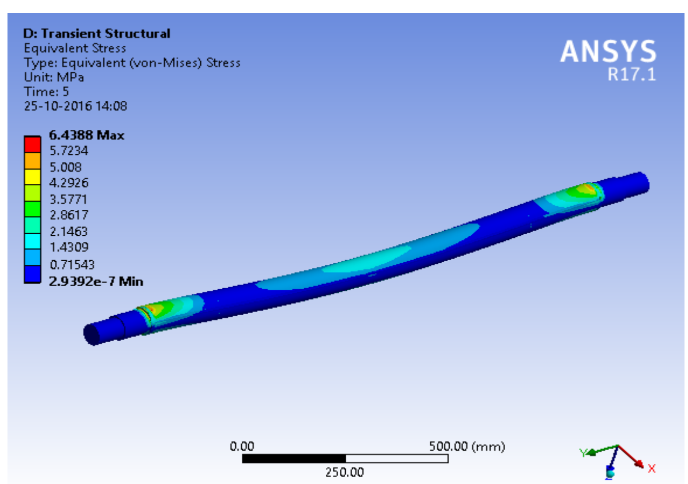
At t = 3



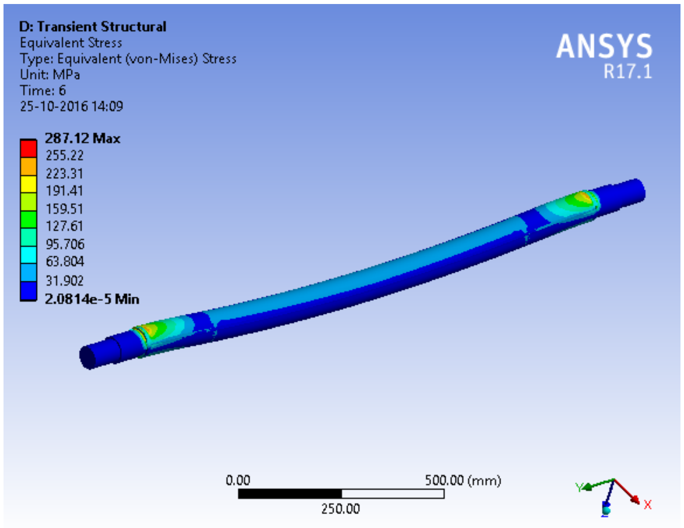
At t = 4



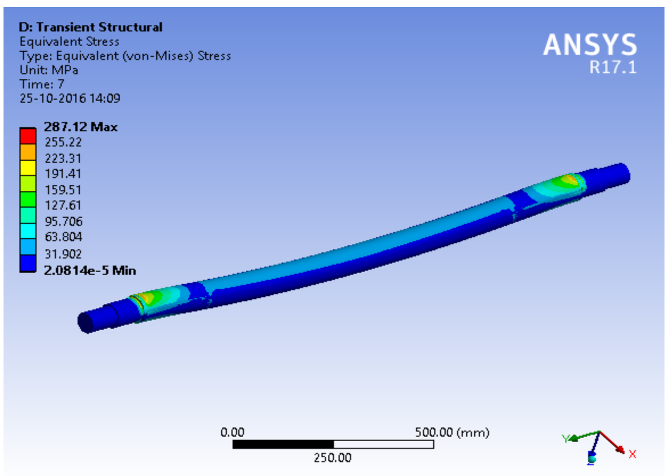
At t = 5



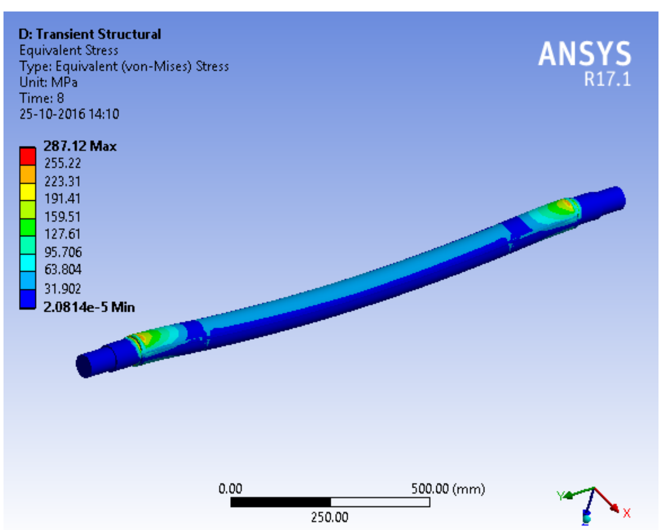
At t = 6



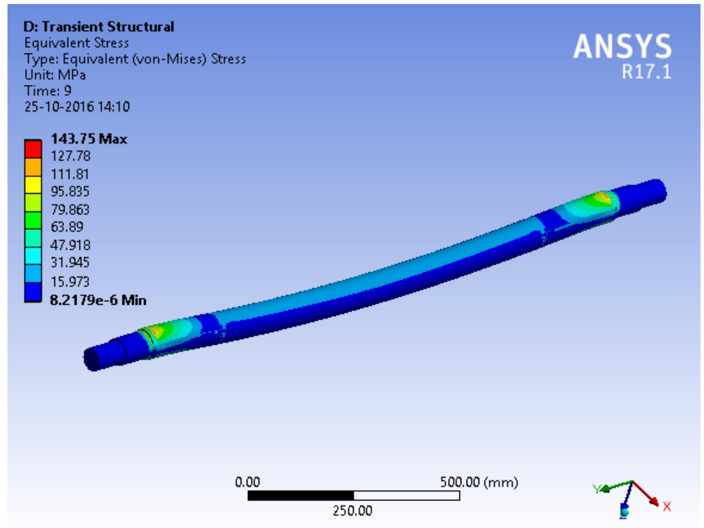
At t=7



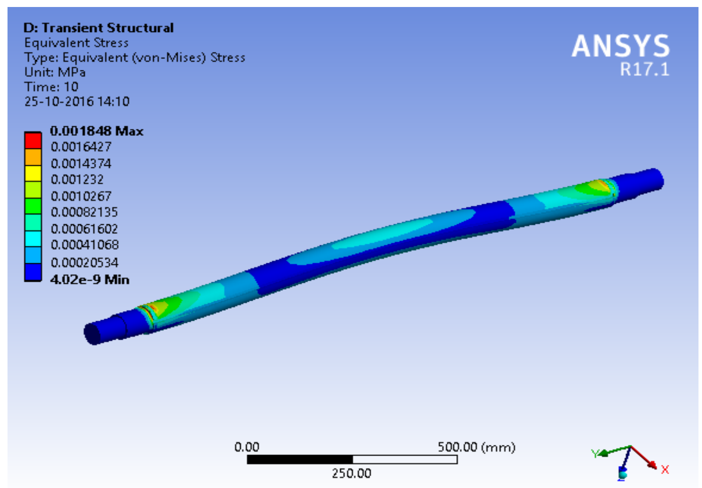
At t=8



At t=9

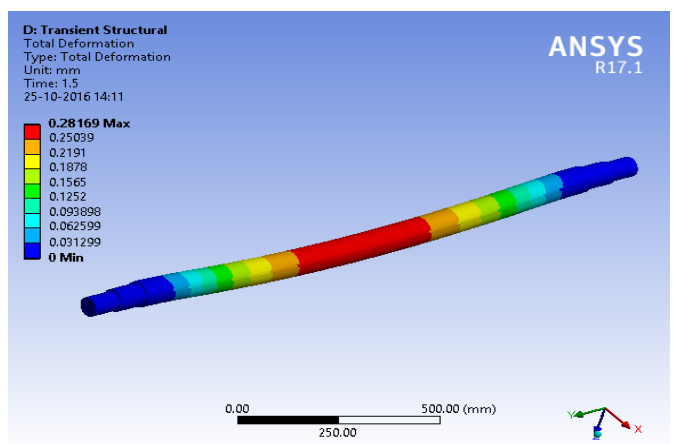


At t=10

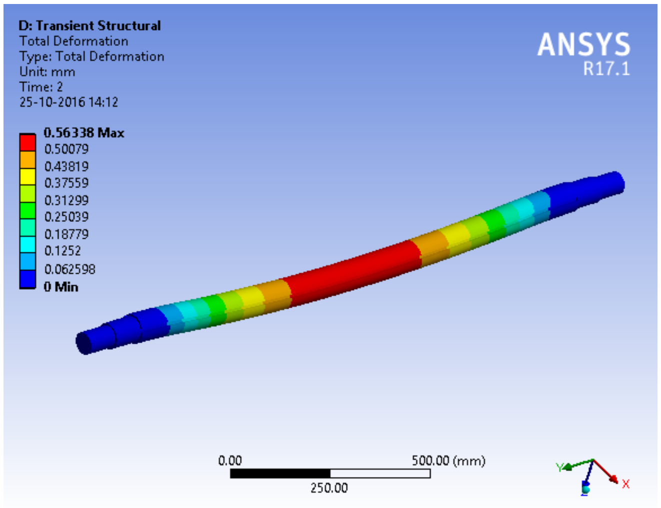


b. Total Deformation

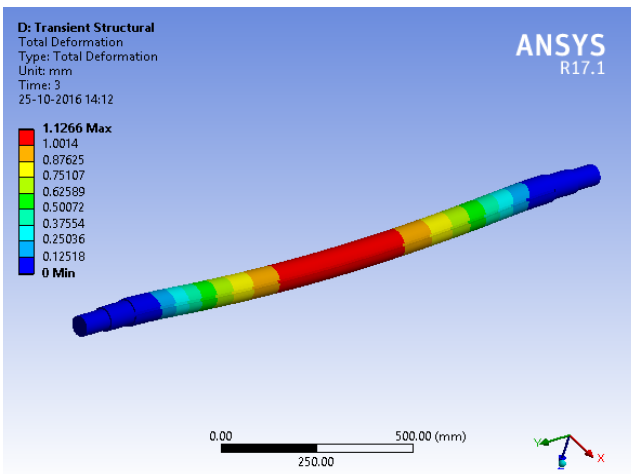
At t=1.5



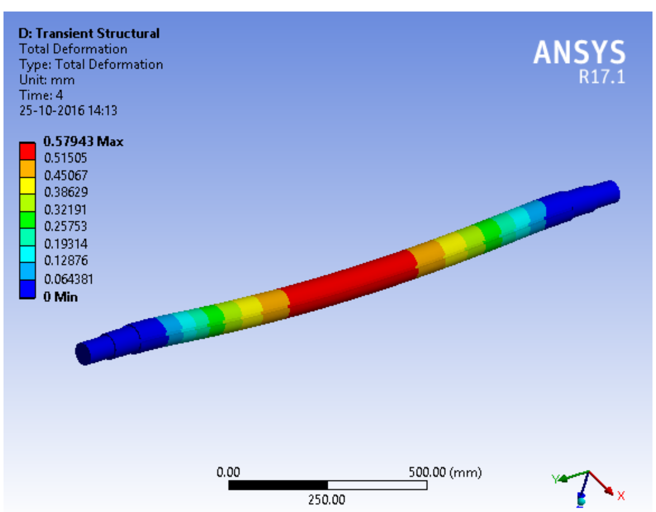
At t=2



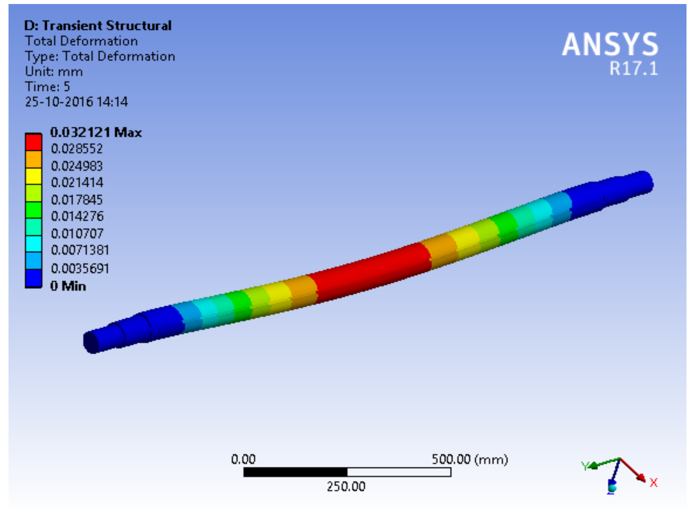
At t=3



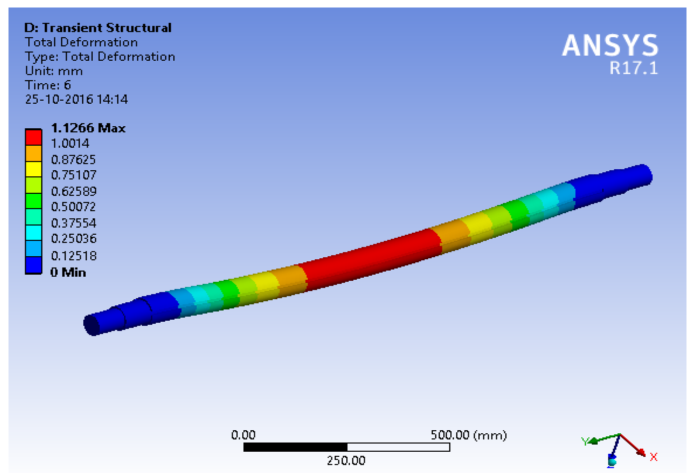
At t=4



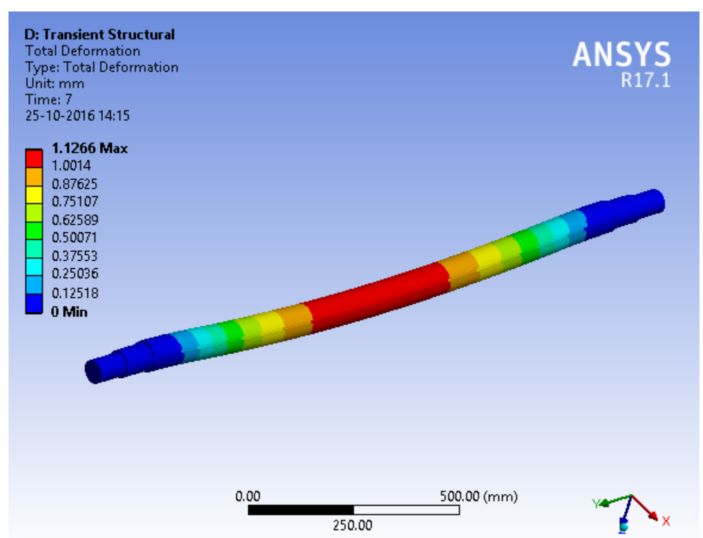
At t=5



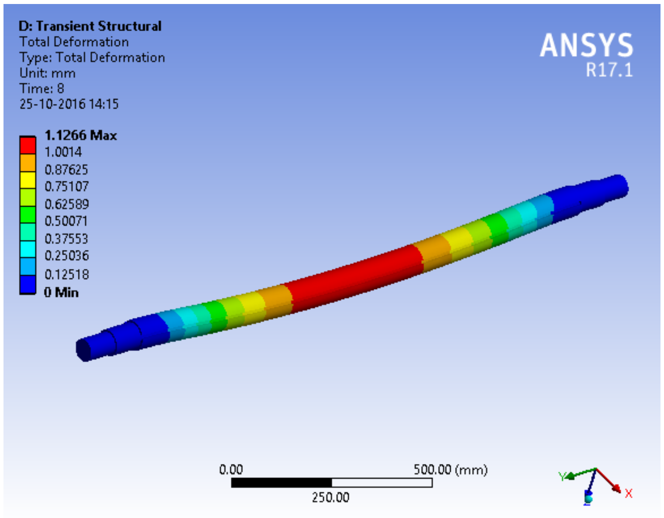
At t=6



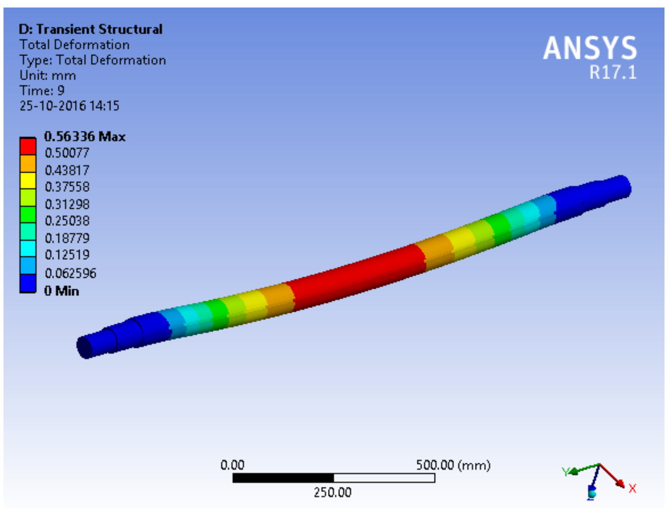
At t=7



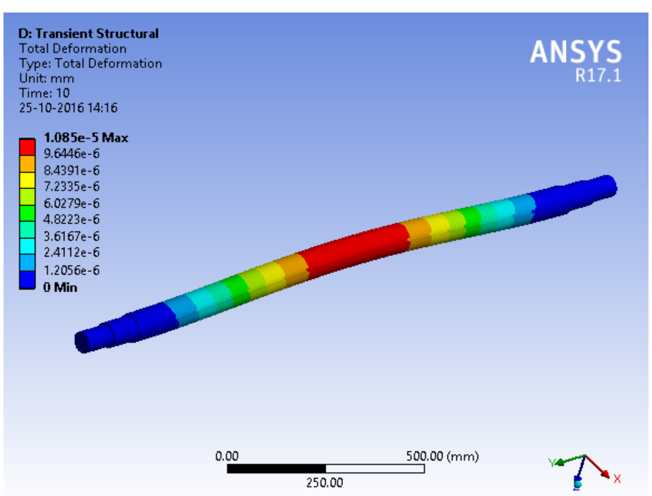
At t=8



At t=9

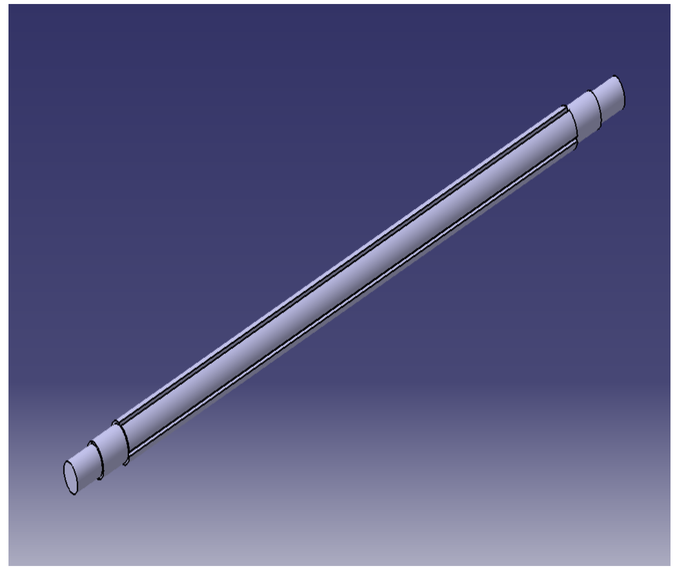


At t=10



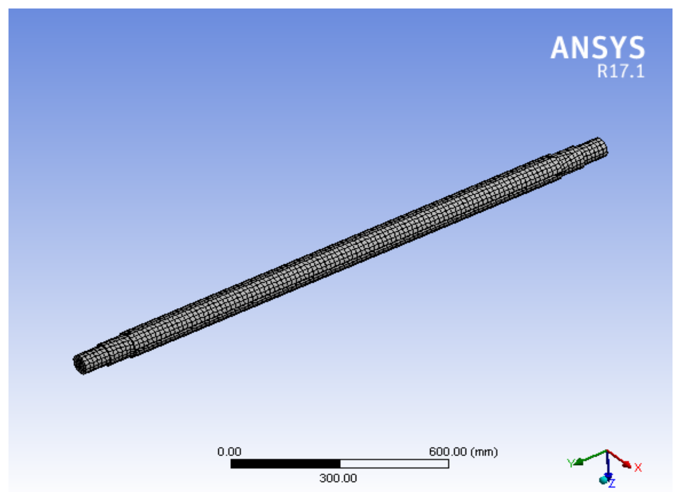
3.2 Dynamic analysis of Axel with four Slots:

1. CAD Model



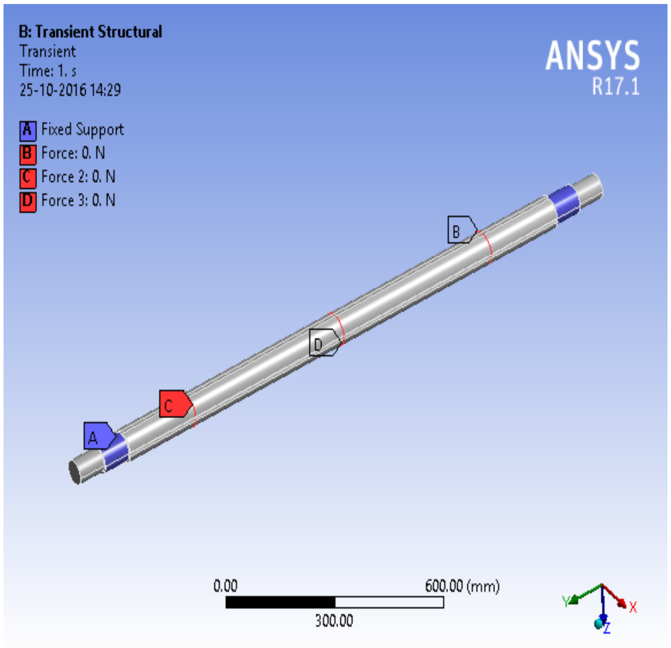
CAD Model with 4 slots

2. Meshing



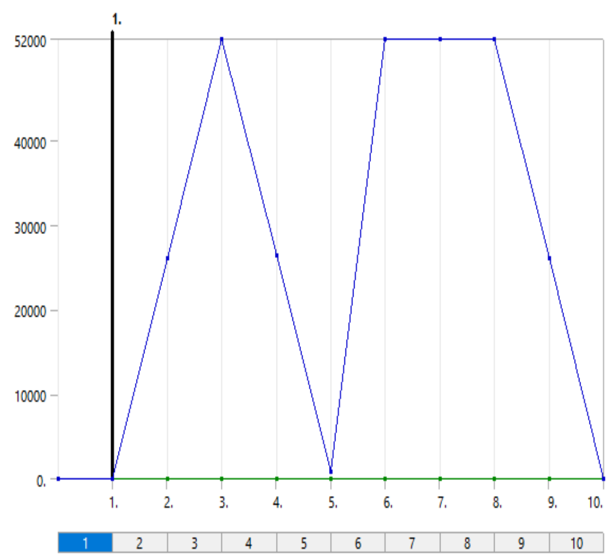
No. of Nodes	30168
No. of Elements	8695

3. Boundary Conditions



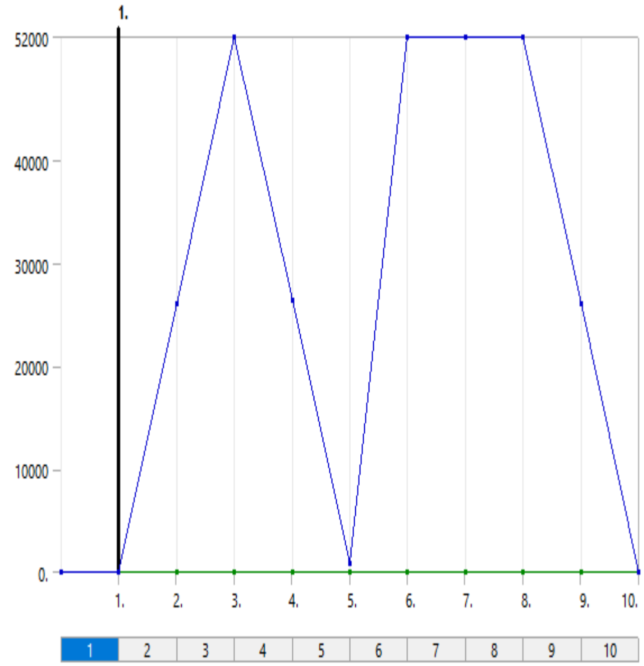
Force applied for Dynamic Condition

4. Force B



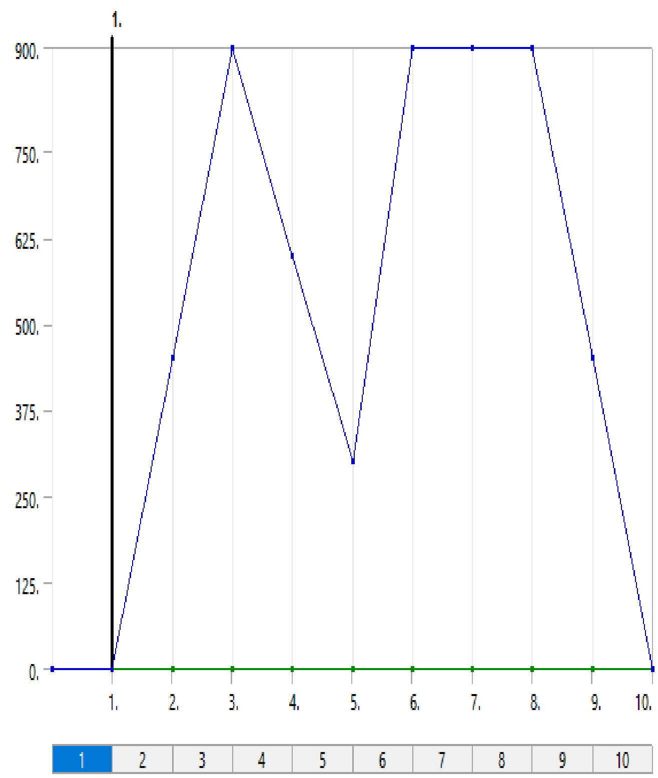
Force applied at point B

5. Force C



Force applied at point C

6. Force D

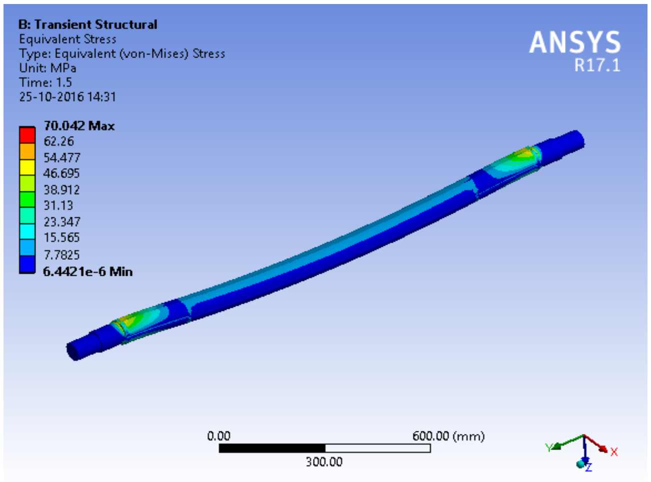


Force applied at poi

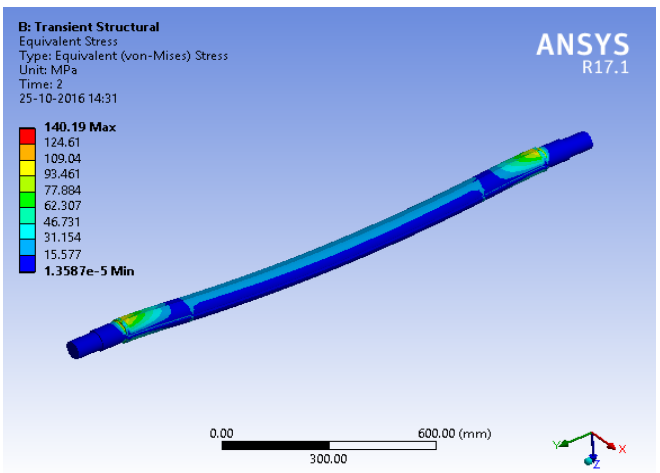
7. Results:

c. Von-Mises Stress

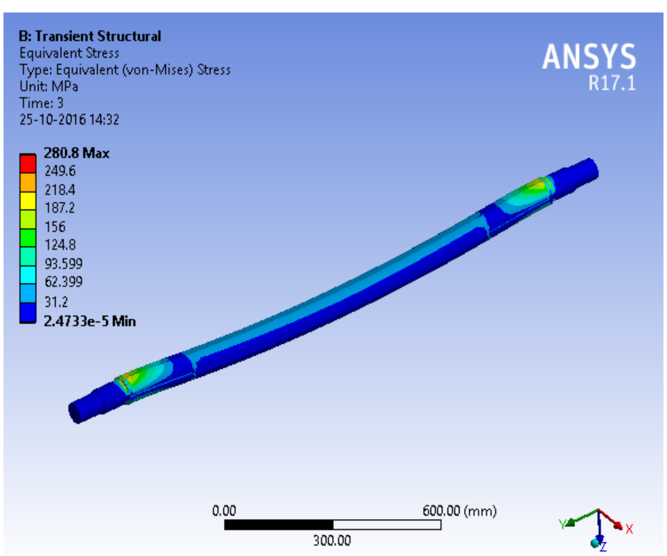
At t = 1.5



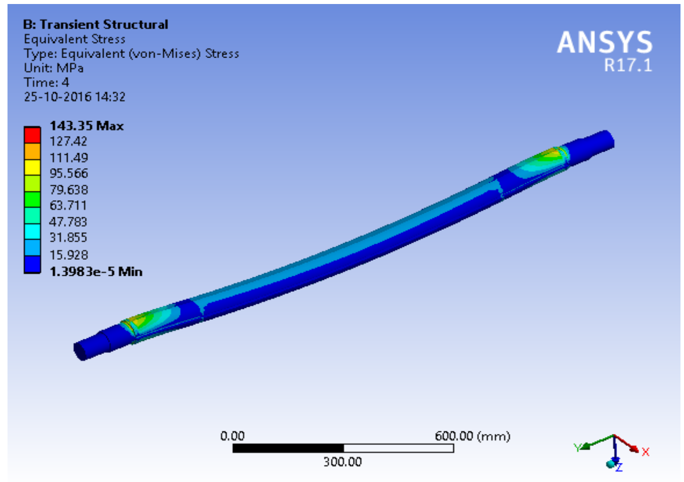
At t=2



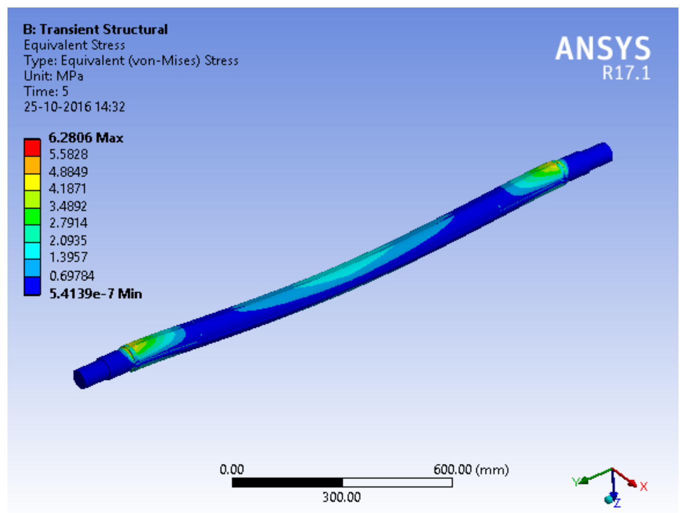
At t = 3



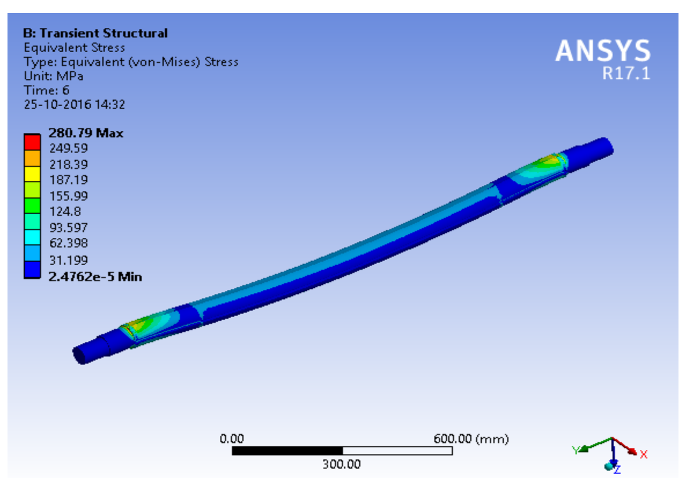
At t = 4



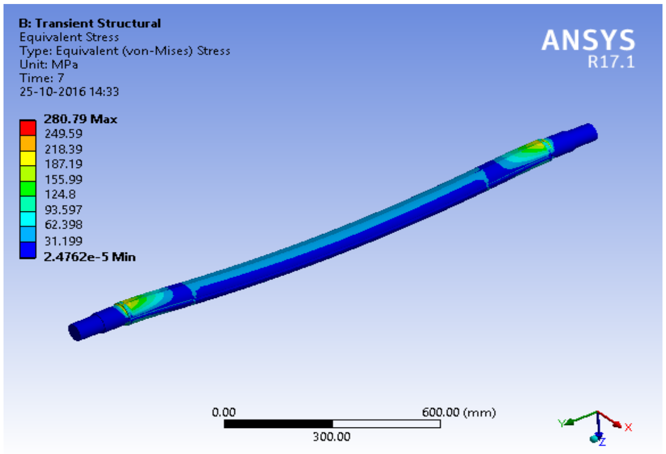
At t = 5



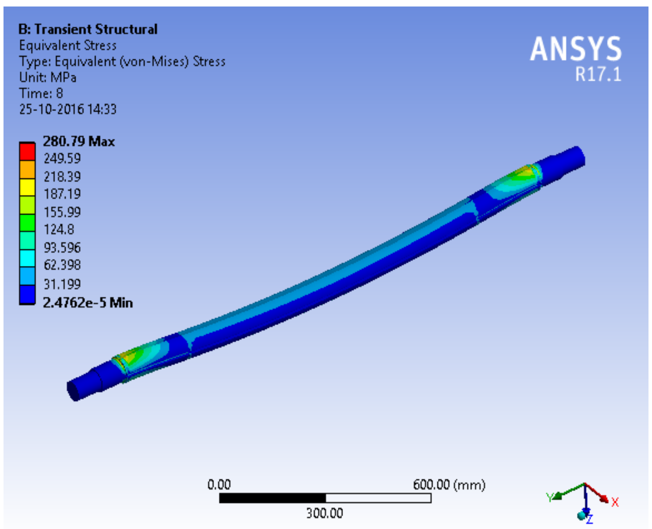
At t = 6



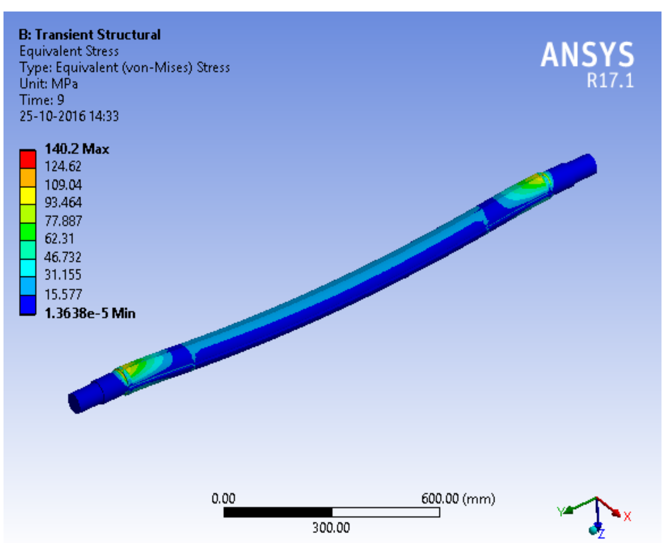
At t=7



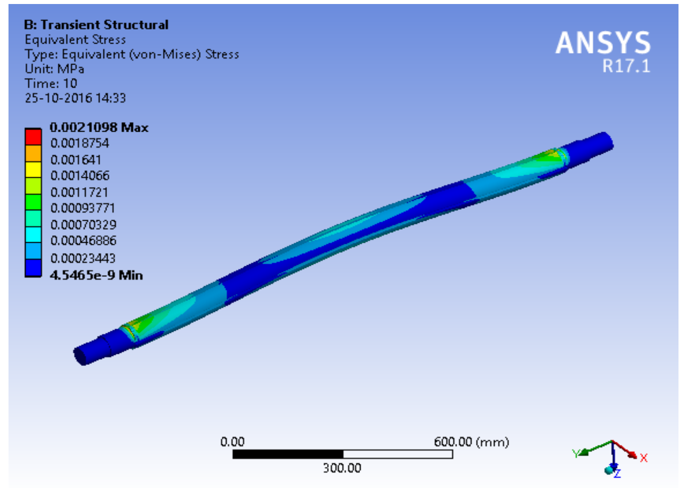
At t=8



At t=9

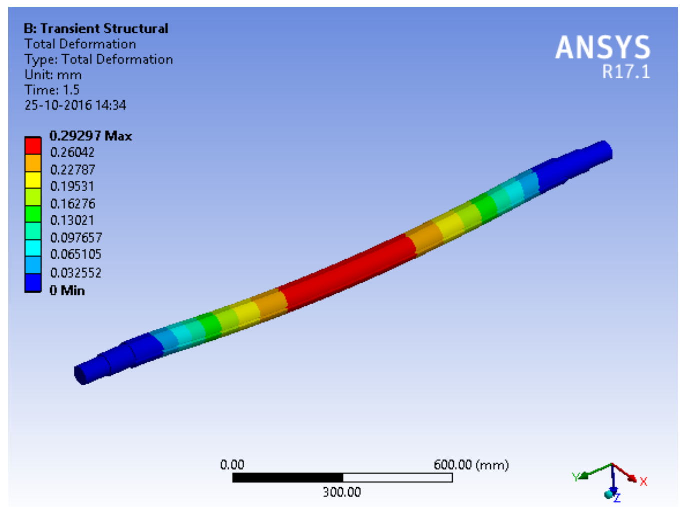


At t=10

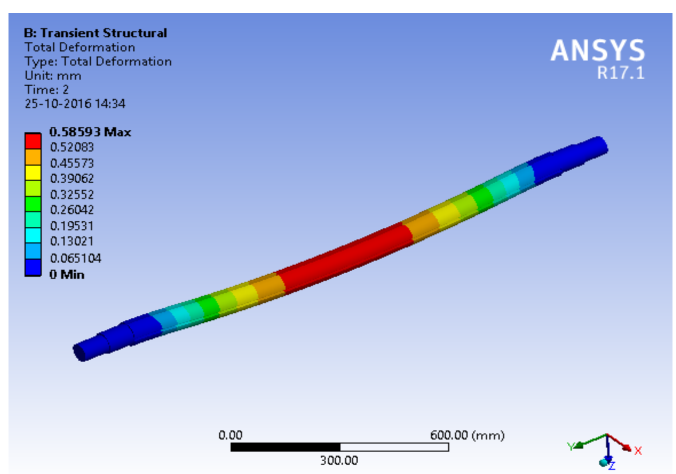


d. Total Deformation

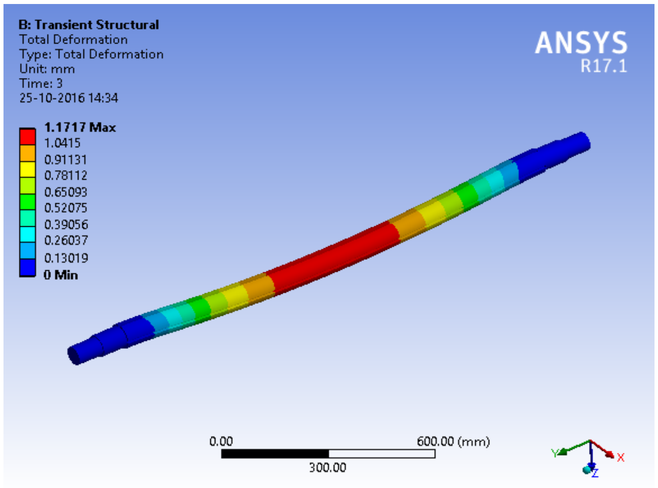
At t=1.5



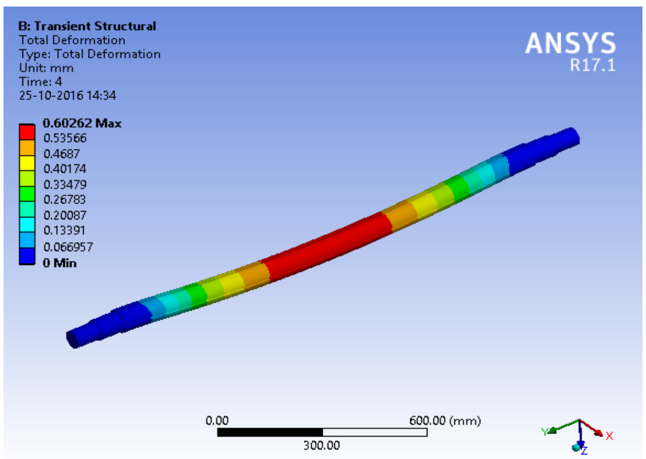
At t=2



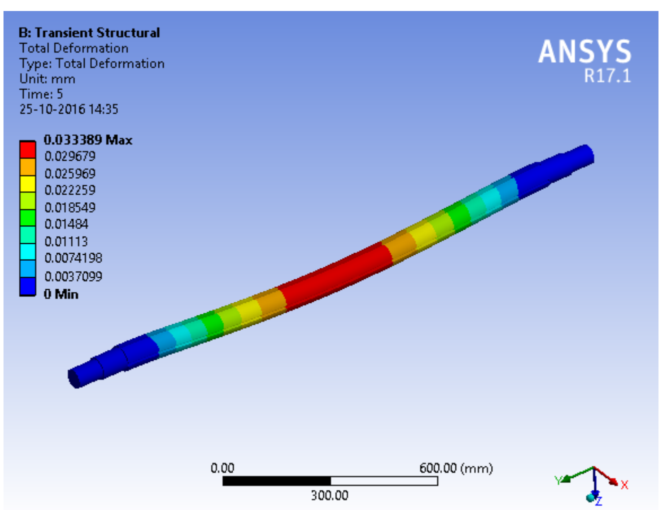
At t=3



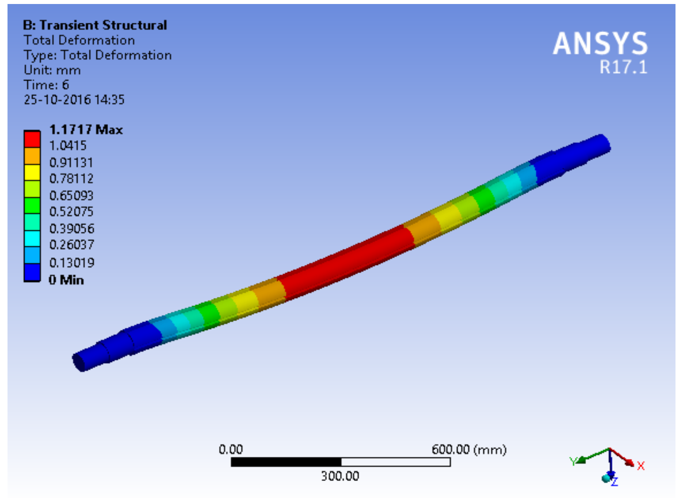
At t=4



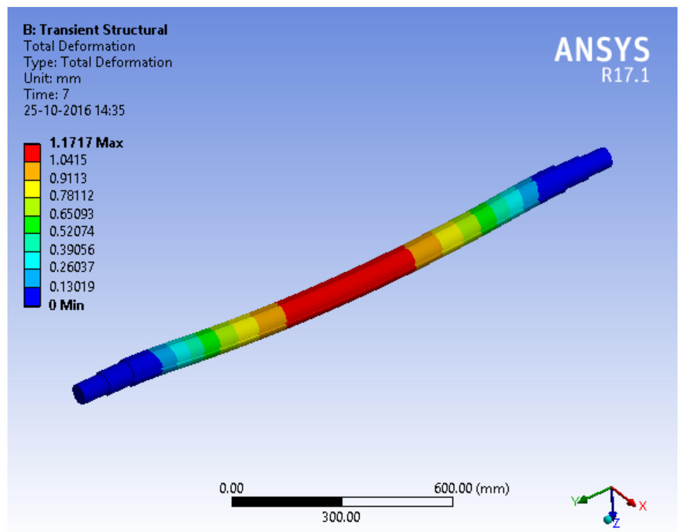
At t=5



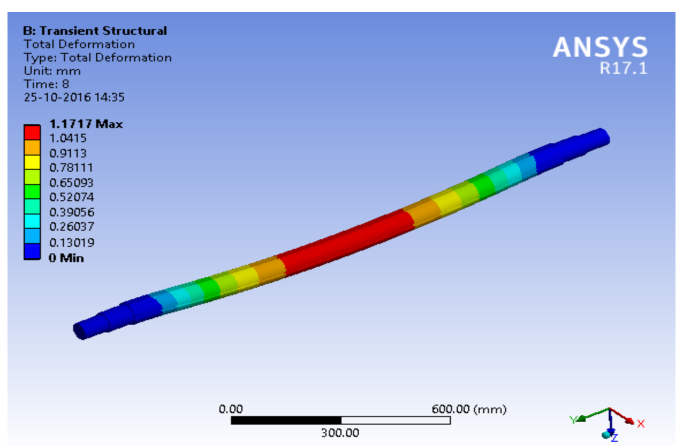
At t=6



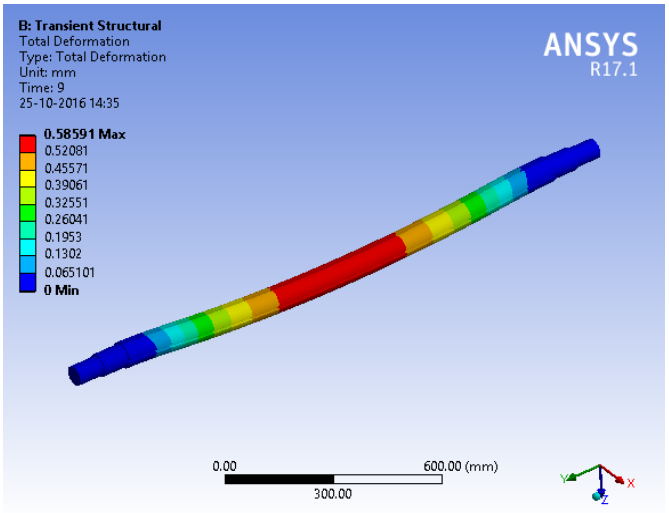
At t=7



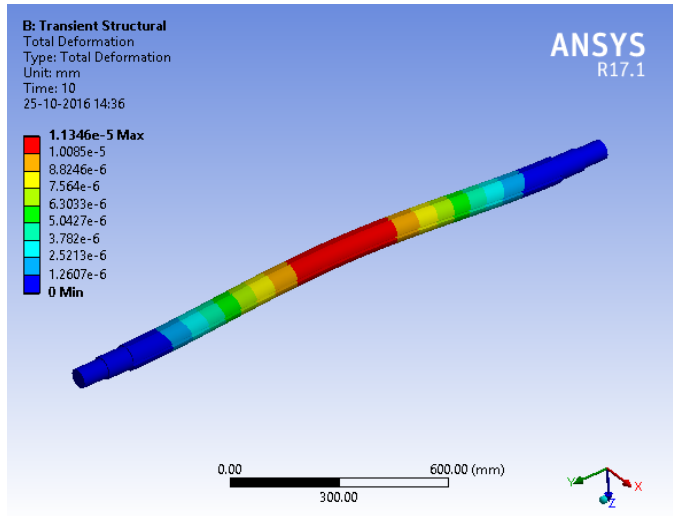
At t=8



At t=9



At t=10



IV. RESULTS

Dynamic Analysis						
	Axle With 3 Slots			Axle With 4 Slots		
Time	Stress	Strain	Deformation	Stress	Strain	Deformation
0.5	0	0	0	0	0	0
1	0	0	0	0	0	0
1.5	71.93	5.36E-04	0.28169	70.042	5.10E-04	0.29297
2	143.76	1.07E-03	0.56338	140.19	1.02E-03	0.58593
2.5	215.49	1.61E-03	0.84501	210.44	1.53E-03	0.87883
3	287.11	2.14E-03	1.1266	280.8	2.05E-03	1.1717
3.5	217.09	1.62E-03	0.85305	212.02	1.54E-03	0.88718
4	146.96	1.09E-03	0.57943	143.35	1.04E-03	0.60262
4.5	76.754	5.72E-04	0.3058	74.764	5.45E-04	0.31803
5	6.4388	4.79E-05	3.21E-02	6.2806	4.57E-05	3.34E-02
5.5	146.97	1.09E-03	0.57944	143.34	1.04E-03	0.60262
6	287.12	2.14E-03	1.1266	280.79	2.05E-03	1.1717
6.5	287.12	2.14E-03	1.1266	280.79	2.05E-03	1.1717
7	287.12	2.14E-03	1.1266	280.79	2.05E-03	1.1717
7.5	287.12	2.14E-03	1.1266	280.79	2.05E-03	1.1717
8	287.12	2.14E-03	1.1266	280.79	2.05E-03	1.1717
8.5	215.49	1.61E-03	0.84502	210.44	1.53E-03	0.87884
9	143.75	1.07E-03	0.56336	140.2	1.02E-03	0.58591
9.5	71.932	5.36E-04	0.28171	70.044	5.10E-04	0.29298
10	1.85E-03	1.27E-08	1.09E-05	2.11E-03	1.49E-08	1.13E-05
Weight (kg)		62.193		61.068		

Detail Comparison of all the results after analysis are shown in above table. From the above result table it is clear that deflections induced in 3 slots axles are minimum as compared to 4 slots also weight of the axle is optimized by modifying existing axle by three slots. Hence based on the material properties and rigidity the design is safe.

V. CONCLUSIONS

1. Bending problem of trolley axle is reduced by using SAE1020 material axle, because based on the strength and rigidity of material.
2. Deflections induced in SAE 1020 material axle is less as compared to MS axle hence failure of trolley axle minimizes
3. On making fine slots instead of reducing thickness weight will further optimizes, and stress concentration reduces due to abrupt change in area by slots. This method gives the optimum results, but it slightly increases the machining cost compare to previous method, but it reduces the running cost.
4. As failure and bending stress for SAE1020 trolley axle reduced, ultimately we can say that strength increases.

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