STRESS ANALYSIS OF COMPRESSED AIR VEHICLE CHASSIS BY FEM

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Abstract

Finite element method has been implemented to modify the existing chassis of compressed air Vehicle (C.A.V.) which ultimately resulted in reduction of weight and equalization of stresses. For analysis, chassis of existing C.A.V. is selected. Analysis is carried out by modifying the existing chassis under the design load capacity. The static load in various members of chassis is identified. The finite element analysis of existing chassis revealed the stress distribution in chassis members. In this work, effort is made to reduce & equalize the stress levels by modifying the structural members of existing chassis so that advantage of weight reduction along with safe stress & its equalization can be obtained. Best modified structure is suggested.

Keywords: Compressed Air Vehicle, Chassis, FEM

1. Introduction

Gasoline emission pollutes the air and the price of oil is also soaring. Therefore research on sustainable energy is being carried out worldwide. One of such technology is use of compressed air vehicles. In the present market scenario, cost reduction techniques are playing significant role to meet the competition in the market. Weight reduction, simplicity in design and application of industrial engineering etc. are the techniques which are used. These products are by and large manufactured as per need & by trial and error methods of manufacturing. These products are getting improved by means of feedback of failure as and when it occurs.

Final year project student batch of Mechanical Engg. Dept. R.C.E.R.T. Chandrapur fabricated C.A.V. during the year 2010-2011 a shown in fig 1. The design of chassis of this vehicle was carried out by them only on the basis of intuition with available structural components. It is seen that, the weight of chassis contributed to 40% of weight of C.A.V. Thus, for better performance of the vehicle, the weight of the chassis needs to be reduced. As the fabrication of chassis is carried out on the basis of intuition only, equalization of stress in all parts of the chassis is not carried out. Due to this unequally of stress distribution in the chassis members there is a possibility that stresses in the members may exceed the safe stress values. So in this work following aspects are considered for better design of chassis for C.A.V.

- To reduce weight of existing chassis.
- Reduction and equalization of stresses along the length of members of chassis.

The schematic sketch of existing chassis with co-ordinates is shown in fig 2 & the cross sections of all members are shown in Table 1.

Fig. 1 : Photograph of C.A.V.

Table 1- Various sections used for Existing Chassis

Sr. No.	Component No.	Section	Dimension of cross section (mm)	Length(mm)	Weight(kg)	Total Weight(kg)
1	Member - 1 Member - 2 Member - 3 Member – 5	L Angle	25x25x2	3010.7	52.11	60.73kg
2	Member – 4	Hollow Rectangular	20x20x5	498.2	8.62	

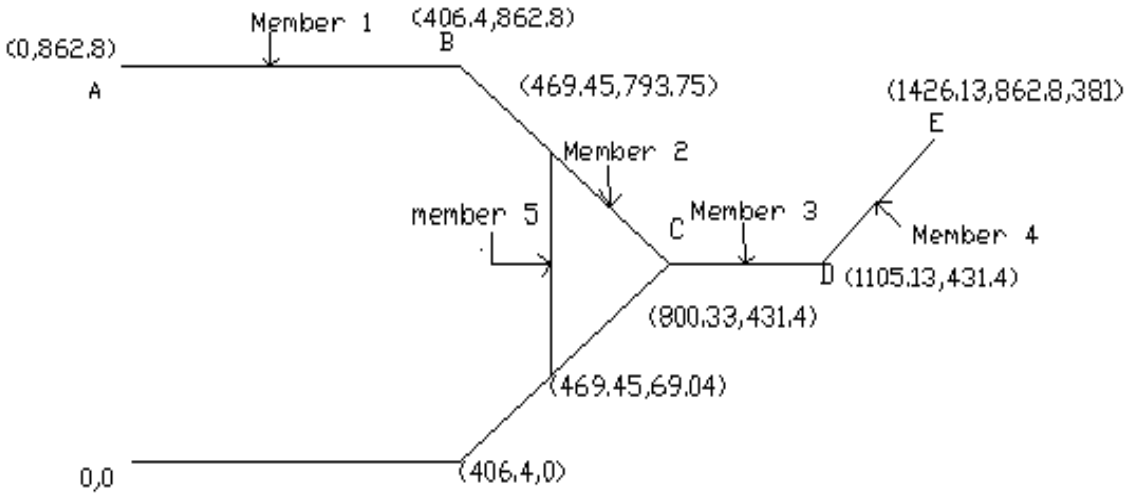

Fig 2- Schematic Diagram of Existing Chassis

2. Finite Element Analysis of Existing Chassis

For finite element analysis, FE modelling of Existing Chassis is carried out using ANSYS. A BEAM 188 element is considered for FE analysis. The FE model of Existing Chassis is shown in fig. 3. The constraints and loads are applied as per actual fixity point and loading points for Existing Chassis. The Von Mises stress contour of Existing Chassis is shown in fig 4.

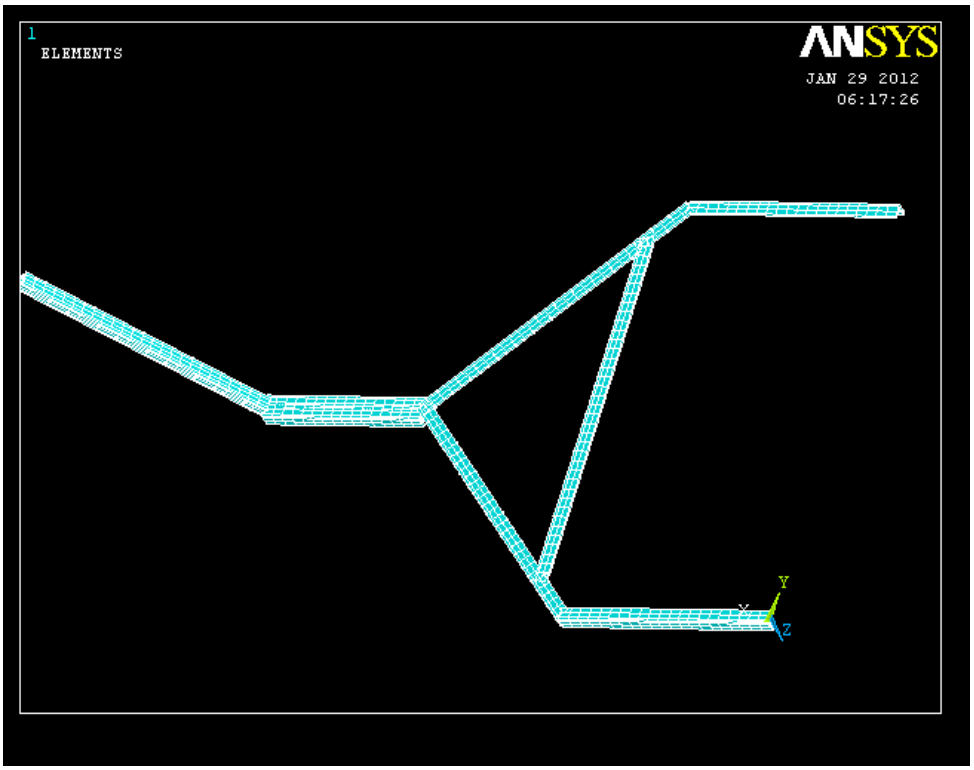

Fig.3 - FE Model of Existing Chassis

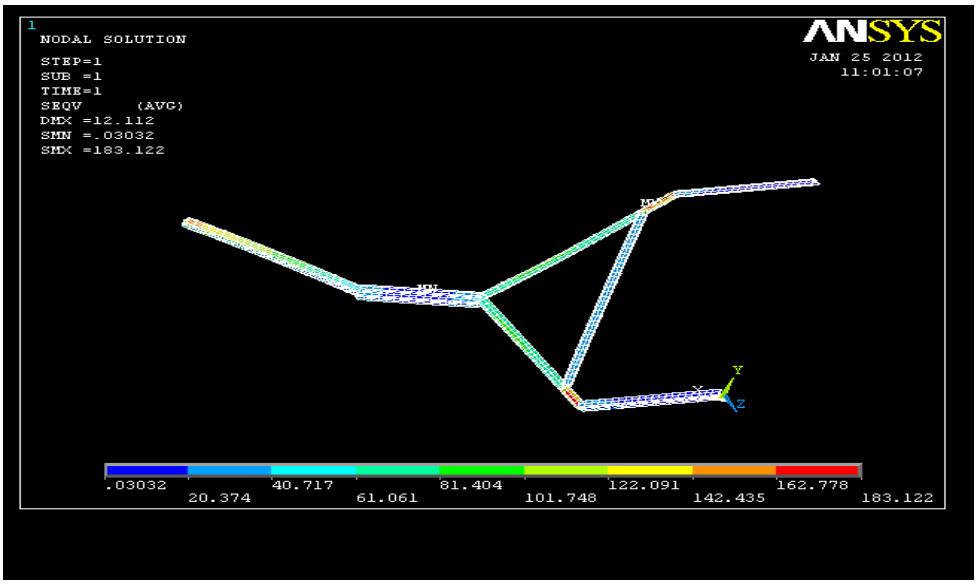

Fig.4 - Von Mises Stresses for Existing Chassis

3. Modification of Existing Chassis

The finite element analysis of Existing Chassis revealed that, the maximum stresses are concentrated only over small portion of chassis members. So an effort is made to reduce & equalize the stress levels by modifying the cross sections of members of Existing Chassis, so that advantage of weight reduction & its equalization for safe stress can be obtained. Different cases considered during modification of Existing Chassis are given in forthcoming sections.

3.1 Case 1

In this case various sections like rectangular, circular & hollow circular are used for FE analysis. The cross section of each members are modified, which are given in Table 2. By considering these cross sections for each member, FE model is developed. The finite element analysis of chassis as per earlier loading and boundary conditions revealed the stress distribution in the form of stress contours. The stress contours for Von Mises stresses are shown in fig. 5.

Table 2 : Various sections used for CASE 1

Sr. No.	Component No.	Section Considered	Dimension of cross section (mm)	Length (mm)
1	Member-1	Hollow Rectangular	20x20x2	812.8
2	Member-2	Hollow Rectangular	20x20x5	1168.4
3	Member-3	Hollow circular	R=20,r=12	304.8
4	Member-4	Circular	R=22	498.2
5	Member-5	Rectangular	10x2	724.7

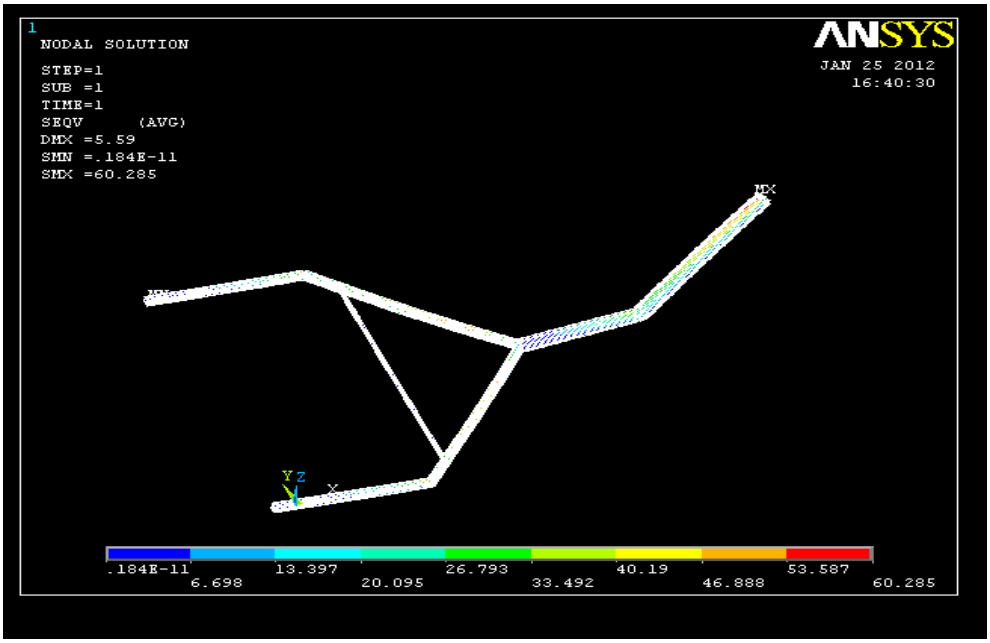

Fig.5 Von Mises Stresses in Chassis for CASE 1

3.2 Case 2

In this case FE analysis is carried out by varying the size of the cross sections of Existing Chassis. The modified dimensions of Existing Chassis are given in Table 3. The finite element analysis of chassis as per loading and boundary condition revealed the stress distribution in form of stress contours. The stress contours of Von-mises stresses are shown in fig. 6.

Table.3. Sections Considered for CASE 2

Sr. No.	Component No.	Section Considered	Dimension of Cross section(mm)	Length (mm)
1	Member 1 Member 2	L Angle	25x25x5	1981.2
2	Member 3	L Angle	30x45x6	609.6
3	Member 4	Hollow Rectangular	40x40x10	498.2
4	Member 5	L Angle	10x10x2	724.7

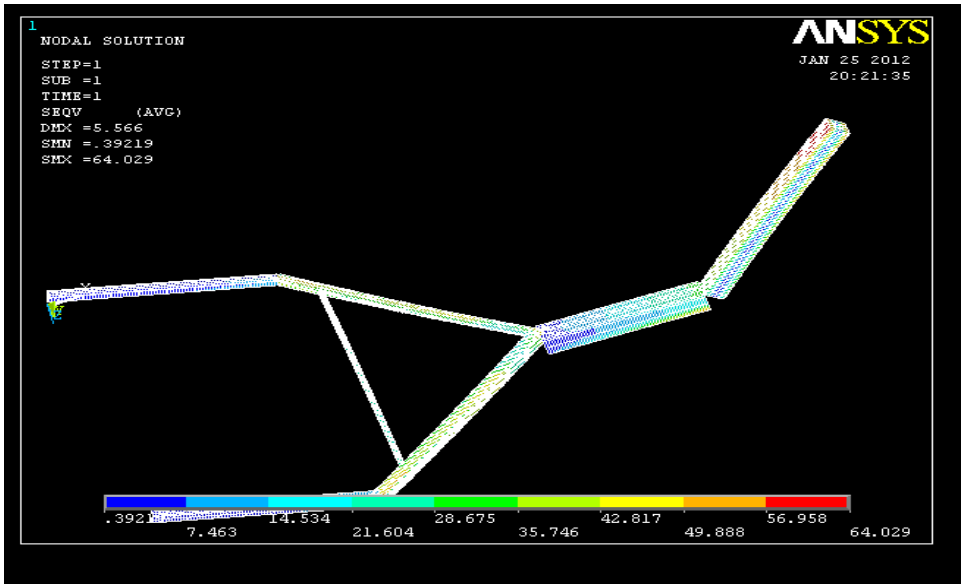

Fig 6 Von Mises Stresses in Modified Chassis for CASE 2

3.3 Case 3

In this case the FE analysis is carried out by varying the size of the cross sections of members of Existing Chassis. The cross sections of each members are modified which are given in Table 4. The finite element analysis of chassis as per loading and boundary condition revealed the stress distribution in the form of stress contours. The stress contours of Von Mises stresses are shown in fig. 7.

Table 4. Sections Considered for CASE 3

Sr. No.	Component No.	Section Considered	Dimension of cross section (mm)	Length (mm)
1	Member-1 Member-2	L Angle	16x23x5	1981.2
2	Member-3	L Angle	30x45x6	609.6
3	Member-4	Hollow Rectangular	40x40x5	498.2
4	Member-5	L Angle	12x12x2	724.7

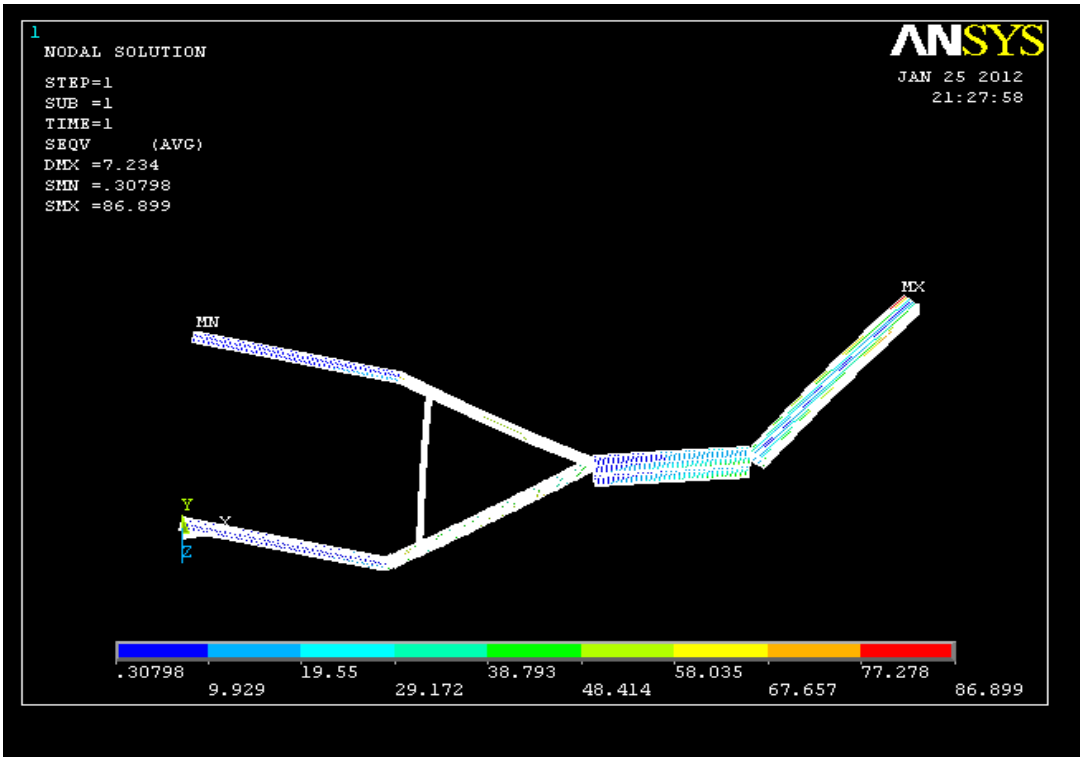

Fig. 7 Von Mises Stresses in Modified Chassis for CASE 3

4. RESULTS, DISCUSSION AND CONCLUSION

Stress analysis of Existing Chassis revealed that, Von Mises stresses are in the range of 1 MPa to 181.34 MPa in the chassis frame. The weight of Existing Chassis is 64.24 Kg. The stress levels present in the chassis are very high & it occurred for Member-2. For the comparison of stresses in Existing Chassis and for all three cases, the variation of Von Mises stresses in all the members along their lengths are shown in figs 8 to 12.

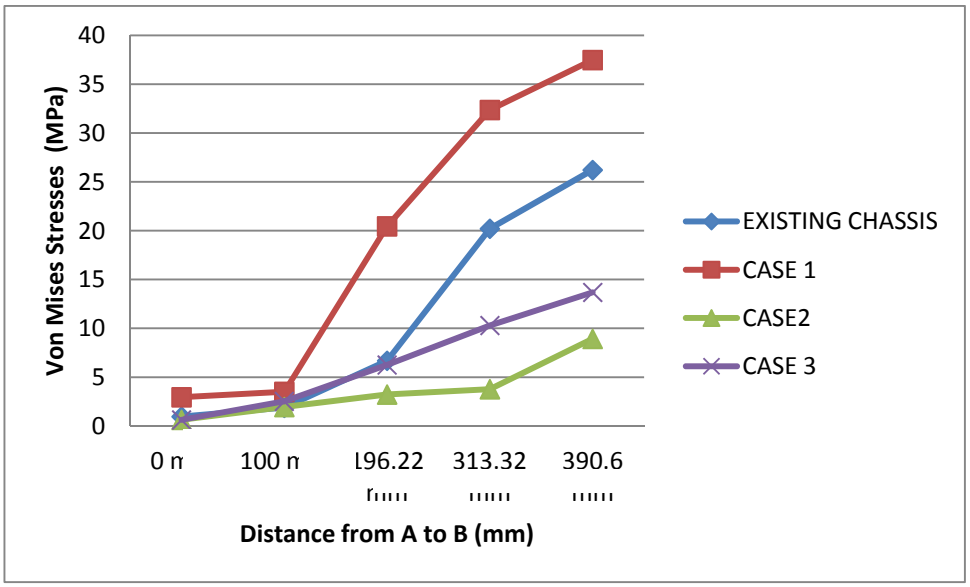

Fig no.8 Von Mises Stresses along the length of Member -1 for Existing Chassis & Modified Chassis

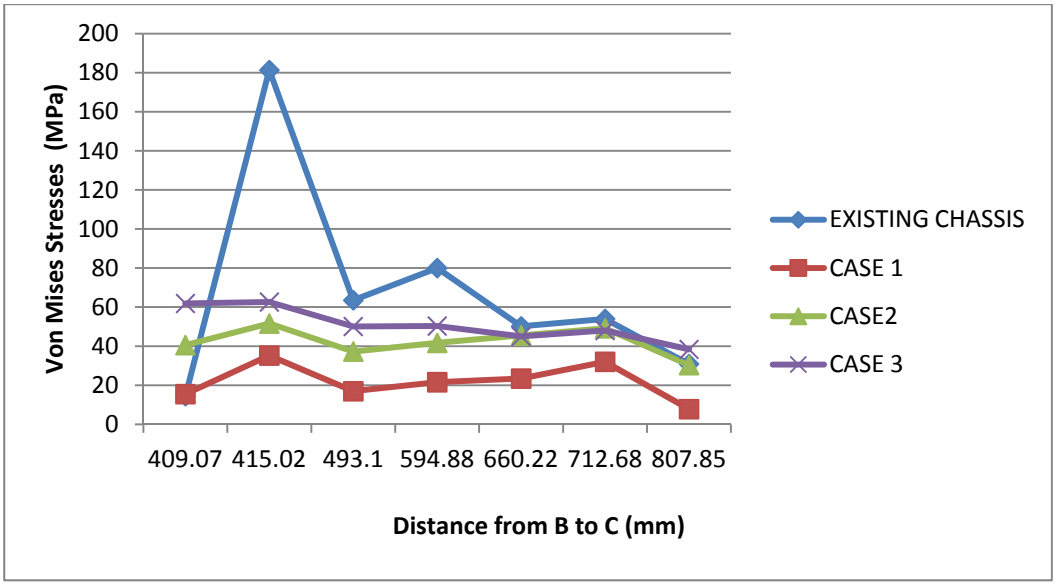

Fig no. 9 Von Mises Stresses along the length of Member-2 for Existing Chassis & Modified Chassis

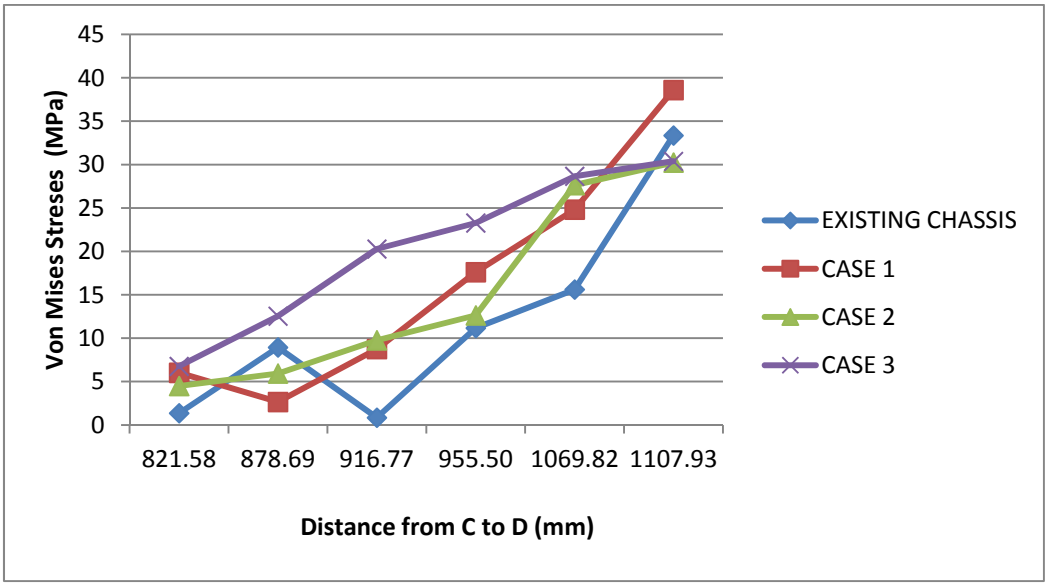

Fig no. 10 Von Mises Stresses along the length of Member-3 for Existing Chassis & Modified Chassis

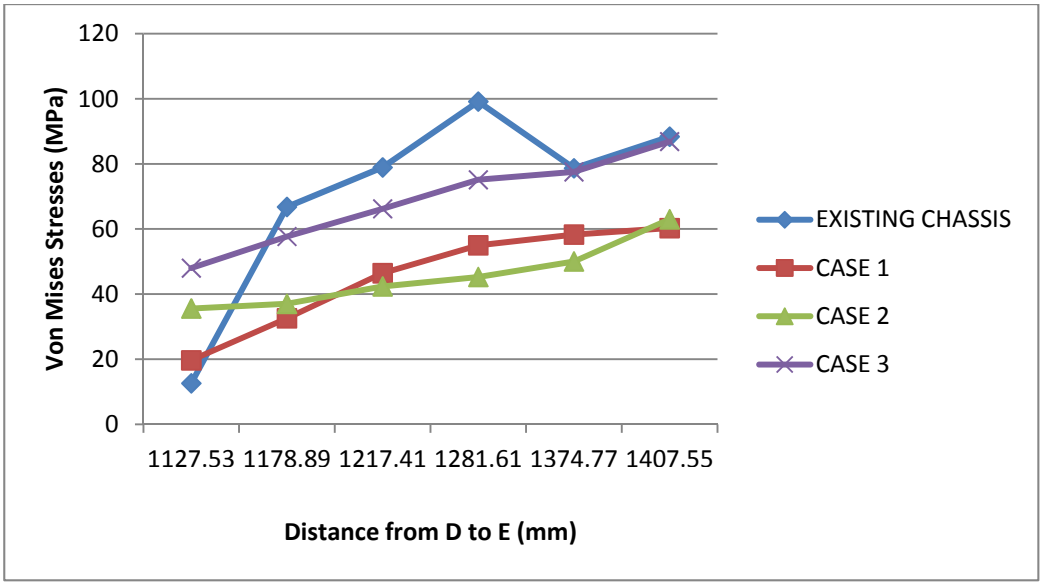

Fig no. 11 Von Mises Stresses along the length of Member-4 for Existing Chassis & Modified Chassis

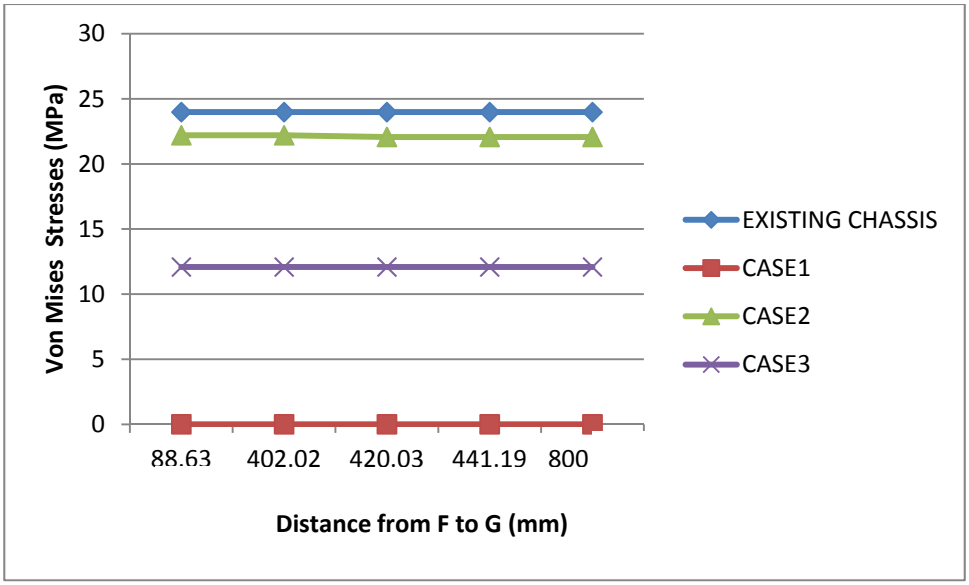

Fig no. 12 Von Mises Stresses along the length of Member-5 for Existing Chassis & Modified Chassis

The variation of Von Mises stresses along the total length for Existing & Modified chassis is shown in fig 13.

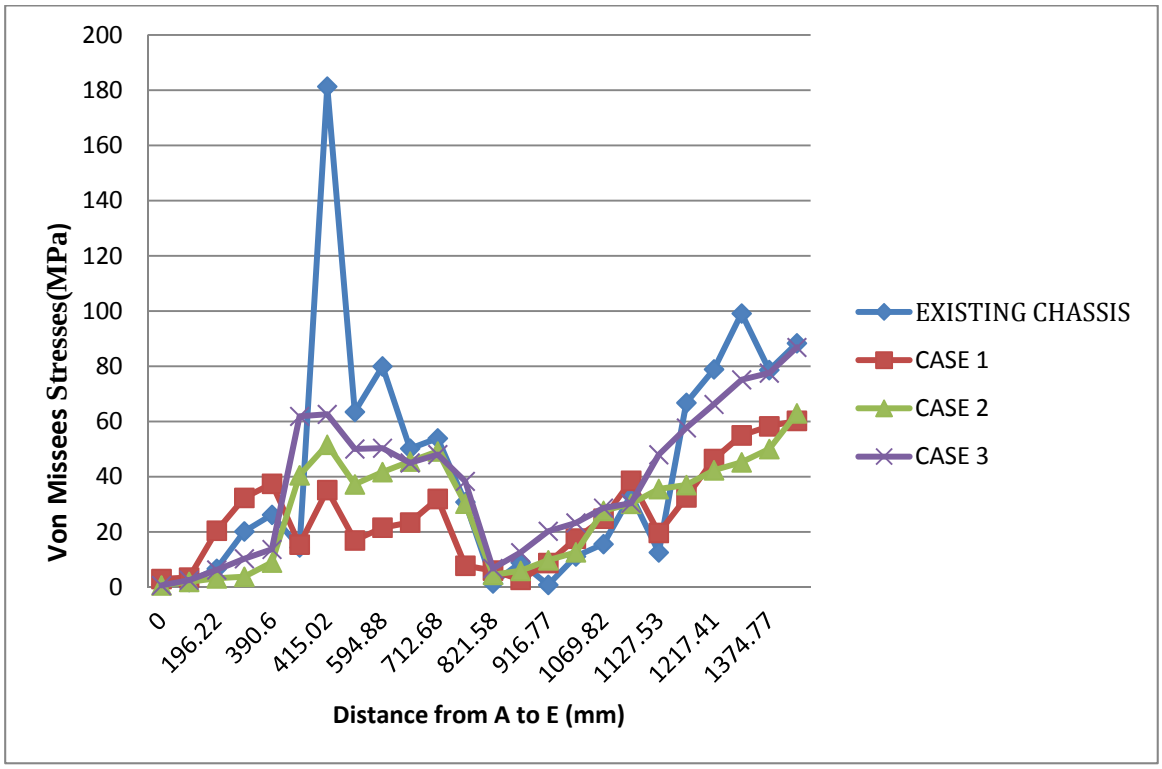

Fig 13 Von Mises Stresses along the length of Member for Existing Chassis & Modified Chassis

The maximum Von Mises stresses present in each member for Existing chassis & for various cases of Modified chassis are given in Table 4.

Table no.4 Maximum Von Mises stresses in various members with weight of Existing Chassis and Modified Chassis

Member	Maximum Von Mises Stresses(MPa)			
	Existing Chassis	CASE 1	CASE 2	CASE 3
1	26.92	37.48	8.93	13.69
2	181.34	35.19	49.16	62.61
3	33.35	38.59	30.24	30.38
4	99.15	60.28	62.99	86.86
5	23.98	0.004	22.2	12.08
Weight of Chassis	64.24 Kg	98.69 Kg	82.3 Kg	58.28 Kg

It is observed from fig.8 that, the least stresses in Member-1 exists for Case 2 & Case 3 with a value of 8.93 MPa & 13.69 MPa respectively. It is also observed that, for these cases stresses are nearly equalized along the length of Member-1. The stresses in Member-1 for Case 1 & also for Existing Chassis are unequalized along the length of Member-1. The stresses in Member-1 for Modified Cases are much lesser than Existing Chassis. Thus preferred cases in order of preference with respect to stresses in Member-1 are Case 2 & Case 3. From fig 9 it is seen that the least stresses in Member-2 exists for Case 1 with a value of 35.19 MPa. It is also observed that the stresses in Member-2 for Existing Chassis are not equalized. But for Case 1, Case 2 & Case 3, the stresses are lesser than Existing chassis & closely equalized along the length of Member-2. Thus preferred cases in order of preference with respect to stresses in Member-2 are Case1, Case 2 & Case 3.

It is seen from fig.10 that, the least stresses in Member-3 exists for Case 2 & Case 3 with a value of 30.24 MPa & 30.38 MPa respectively. Maximum stresses in Member-3 are nearly same for Existing chassis & for Modified chassis. The stresses are not equalized neither for Existing chassis nor for Modified chassis for Member-3. Therefore any of these cases may be preferred. Fig 11 shows that, the least stress in Member-4 exists for Case 1 & Case 2 with a value of 60.28 MPa & 62.99 MPa respectively. The maximum stress in Existing Chassis for Member-4 is 99.15 MPa. It is observed that, the stresses in Existing Chassis for Member-4 are not equalized along the length of member. But for Case 1, Case 2 & Case3, it is seen that stresses are closely equalized. Thus preferred cases in order of preference with respect to stresses in Member-4 are Case1, Case 2 & Case 3.

Fig 12 reveals that, the least stresses in Member-5 exists for Case 1 with a negligible value. It is observed that, the stresses in Member-5 for Case 1, Case 2 & Case 3 are lesser than Existing Chassis. The stresses are equalized for all these cases along the length of Member-5. Thus preferred cases in order of preference with respect to stresses in Member-5 are Case1, Case 3 & Case 2. In Case 1 the weight of chassis is 98.69 Kg which is 53.53% more than weight of Existing Chassis & for Case 2 the weight is also16.37% more than weight of Existing Chassis. So Case 1 & Case 2 are not recommended though the stresses are nearly equalized.

The weight of Existing Chassis is 64.24 Kg. But the weight of chassis for Case 3 is 58.28 Kg which is 10% lesser than weight of existing chassis. From fig 13 it is seen that, the stresses are closely equalized in all the member for Case 3 and they are in safe limits. Factor of safety of approximately 3 is achieved for Case 3. Thus Case 3 may finally be recommended for less weight, lesser stress values & equalized stresses.

REFERENCES

[1] Ebrahim Ebrahimi, Alimohamad Borghei, Morteza Almasi,"Design, Fabrication, and Testing of a Hay Bale Trailer", Research Journal of Applied Sciences, Engineering and Technology, Maxwell Scientific Organization,2010(Web resource)

[2] Roslan Abd Rahman, Mohd Nasir Tamin, Ojo Kurdi,"Stress analysis of Heavy Duty Truck Chassis using Finite Element Method", (Web resource)

[3] J. Gadus,"Optimization of Frameworks by means of FEM use" Slovak Agricultural University, Nitra, Slovak Republic. (Web resource)

[4] S.S.Sane, Ghanashyam Jadhav, Anandaraj H. " Stress analysis of Light Commercial Vehicle Chassis by FEM" Piaggio Vehicles Pvt Ltd Pune. (Web resource)

[5] Somsak Siwadamrongpong, Usawadee Ongarjwutichai "Simulation and Design of Production Jigs for Bus Chassis ", System Science and Simulation in Engineering, Thailand. (Web resource)

[6] Ashutosh Dubey, Vivek Dwivedi," Vehicle Chassis Analysis: Load Cases & Boundary Conditions for Stress Analysis" (Web resource)

[7] Dr.R.K. Bansal "Strength of Material ", , Laxmi Publication Ltd, 3 rd edition, 1998

[8] Tirupathi V. Chandrupatala, Ashok D.Belegundu "Introduction to Finite Elements in Engineering", Pearson education, New Delhi, 6 th edition, 2008.