

# **Optimization of Existing Design of Truck Upper Berth of TATA Motors**

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**ABSTRACT:** The present work is the modification in the existing design of conductor berth of TATA Motors, Truck Division. AMA Enterprises, Jamshedpur is the supplier of conductor berth to TATA Motors. The task assigned is to design, fabricate and carry out the detailed optimization of berth to overcome the basic limitations of the present cost of manufacturing in heavy commercial vehicles. The improvement in design must concentrate on strength, proper shape and size i.e. ergonomic aspect within the permissible limits of ARAI. The optimization process will involve developing the CAD model of existing TATA design and modifying it in accordance to standard specifications. Subsequently this optimization will benefit the Automobile industry in large specifically HCV. It is expected that the berth must have good antedate characteristics, their effectiveness should not decrease with prolonged time & also reduction in weight.

**KEYWORDS:** Conductor Berth, Bending Moment, ARAI, FEA.

## **I. INTRODUCTION**

A berth is a bed or sleeping accommodation on vehicles. Space accommodations have contributed to certain common design elements of berths i.e. Berths of long-distance trucks. Long-haul truckers sleep in berths when required by regulations to rest. The sleeper-berth must meet size and location requirements specified on the truck regulations. Upper Berth means sleeper berth which is on the upper side/ deck, where driver or conductor can only use for rest and sleeping purpose.

## **II. LITERATURE SURVEY**

1. Chinnadurai, V., Venna, H., and Banthia, V., "Design of Safety System for Sleeper Berth of Heavy Duty Truck Cabin," SAE Technical Paper 2015-26-0158, doi:10.4271/2015-26-0158, (2015)--In this work, design of such berths from occupant safety point of view has been assessed. Kinematics of occupants, sleeping in different typical postures, during frontal impact, has been simulated and resulting critical injury levels have been estimated. Based on this information, different arrangements of belts in "screen" type configuration were developed. The aim of this design was to restrict movement of the occupants within the confines of the berth, preventing the possibility of them coming off the berth and hitting other parts of the cabin interior. Effectiveness of the restraint systems was assessed based on injury levels for head, thorax, pelvis and chest of occupants. It was found that use of these restraint systems has the potential to reduce HIC levels of the occupants by 25% (for Fetus 1 sleeping position) to 60% (for Soldier sleeping position). Similar reductions were obtained for other injuries also.
2. Parkinson, M. B., Reed, M. P., Kokkolaras, M., & Papalambros, P. Y. Optimizing Truck Cab Layout for Driver Accommodation. Journal of Mechanical Design, 129(11), 1110-1117. Doi: 10.1115/1.2771181, (2006)--A case study involving the layout of the interior of a heavy truck cab is presented, focusing on simultaneous placement of the seat and steering-wheel adjustment ranges. Trade-offs between adjustability (an indicator of cost), driver accommodation, and safety are explored under this paradigm. The report concluded that Educational efforts directed at drivers to understand safety comfort features should be intensified. Further ergonomics and human

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factors research should be undertaken on the various design and interface variables for different brands and models of trucks and seats.

3. Cann, A. P., Salmoni, A. W., & Eger, T. R. Predictors of whole-body vibration exposure experienced by highway transport truck operators. *Ergonomics*, 47(13), 1432-1453. doi: 10.1080/00140130410001712618, (2004) --This study describes the development of a specific intervention programme aiming on a reduction of WBV exposure to drivers at work induced by a change in behaviour. To make a reduction in WBV exposure possible, we tried to change the behaviour or at least the intention to change the behaviour concerning WBV exposure of the drivers and the employers. In this intervention programme the specific role of the employer, next to taking his responsibility for the improvement of the working environment, was to enable the driver to change the behaviour concerning WBV exposure.
4. Guan, J., Hsiao, H., Bradtmiller, B., Kau, T.-Y., Reed, M., Jahns, S., & Loczi, H. H., L. U.S. truck driver anthropometric study and multivariate anthropometric models for cab designs. *Human Factors*, 54(5), 849-871, (2012) -- This project aims to make the most cost effective safety device (safety belt) more users' friendly and hence more widely used, as well as reducing the incidence of musculo-skeletal disorders, driver distraction, driver fatigue and slips and falls. With regard to slipping and falling from the vehicle, while most trucks have steps and handrails, drivers often fail to use them – either because they are in hurry or these exit aids are not designed to suit drivers of all anthropometric dimensions. The injuries sustained in falls from trucks can cause serious injuries as exiting from a cab-level or trailer-level can result in impact forces as high as 12 times the driver's body weight.

### III. PROBLEM STATEMENT

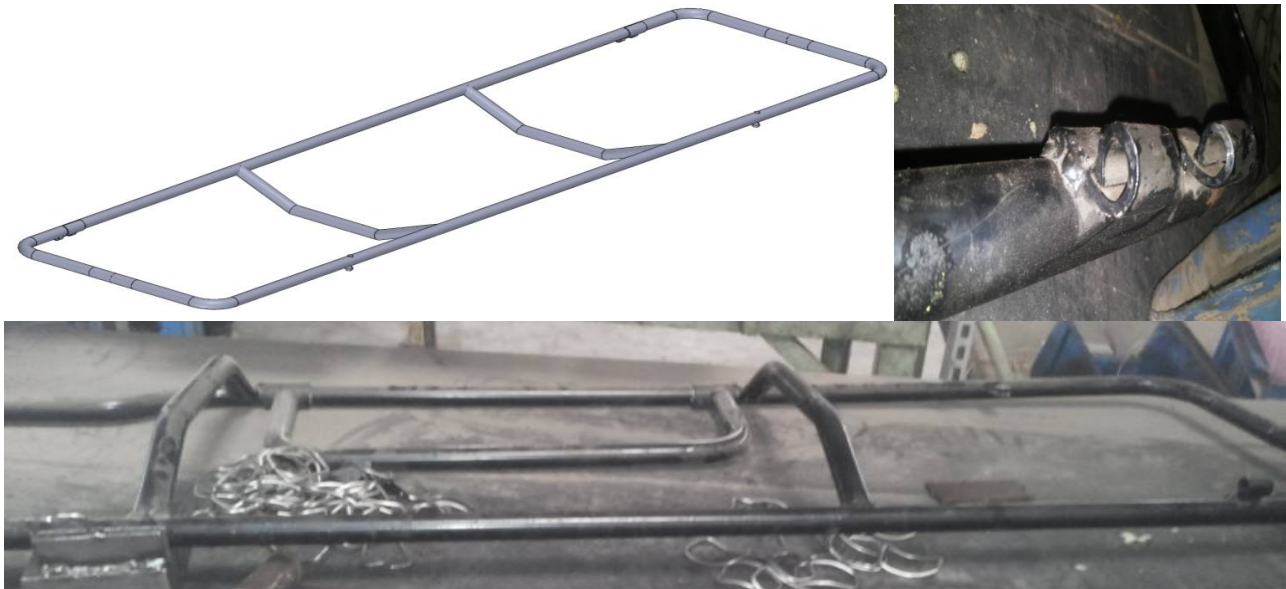
1. Its optimization is the main problem because we have to do optimization such that optimized model of truck upper berth is beneficial to automotive industry especially to AMA enterprises.
2. Secondly we have to consider its weight, because if weight is more of upper berth then it will not satisfy the needs of supplier who have to deal with their customer/client such as TATA motors. Weight should be reduced to fulfil the AMA enterprise's needs.
3. Weight should be reduced so that manufacturing cost is reduced. For reducing cost, we will have to use either low grade material or to reduce its section or thickness up to certain limit but in accordance with ARAI specification.
4. By reducing section or thickness there may be chance to get failure in analysis of model beyond the ARAI specification than the original existing model of TATA motors.
5. Though, by reducing weight we may achieve low manufacturing rate and high productivity but its strength is to be considered because reducing weight may cause some extent of failure in strength of model.
6. Lastly its weight carrying capacity is also to be considered. The weight of sleeping person/driver or truck conductor may be more somewhat above 100 kg up to 200kg is to be considered. Hence after considering this drawback and making optimized model its productivity could be increased by AMA enterprises of our optimized model.

### IV. ERGONOMICS FACTOR

1. Human Maximum Height  $\leq 6.5$  feet.
2. Human Maximum Weight  $\leq 200$  kg.
3. Checking with ARAI Specification that Length of the berth should be minimum 1800 mm & Width of the berth should be minimum 500-700mm for 1x2 layouts.

### V. EXISTING CAD & FABRICATED MODEL

Fig. 1 shows the CAD model and fabricated model of original existing industrial model which AMA enterprises supply to the TATA motors (a) Layout of existing truck upper berth



(a)

### VI. OPTIMIZED CAD & FABRICATED MODEL

Fig. 2 shows the CAD model and fabricated model of final optimized model done after analysing the existing model in order to optimize the existing model for reducing manufacturing cost of AMA enterprises (a) Layout of optimized truck upper berth



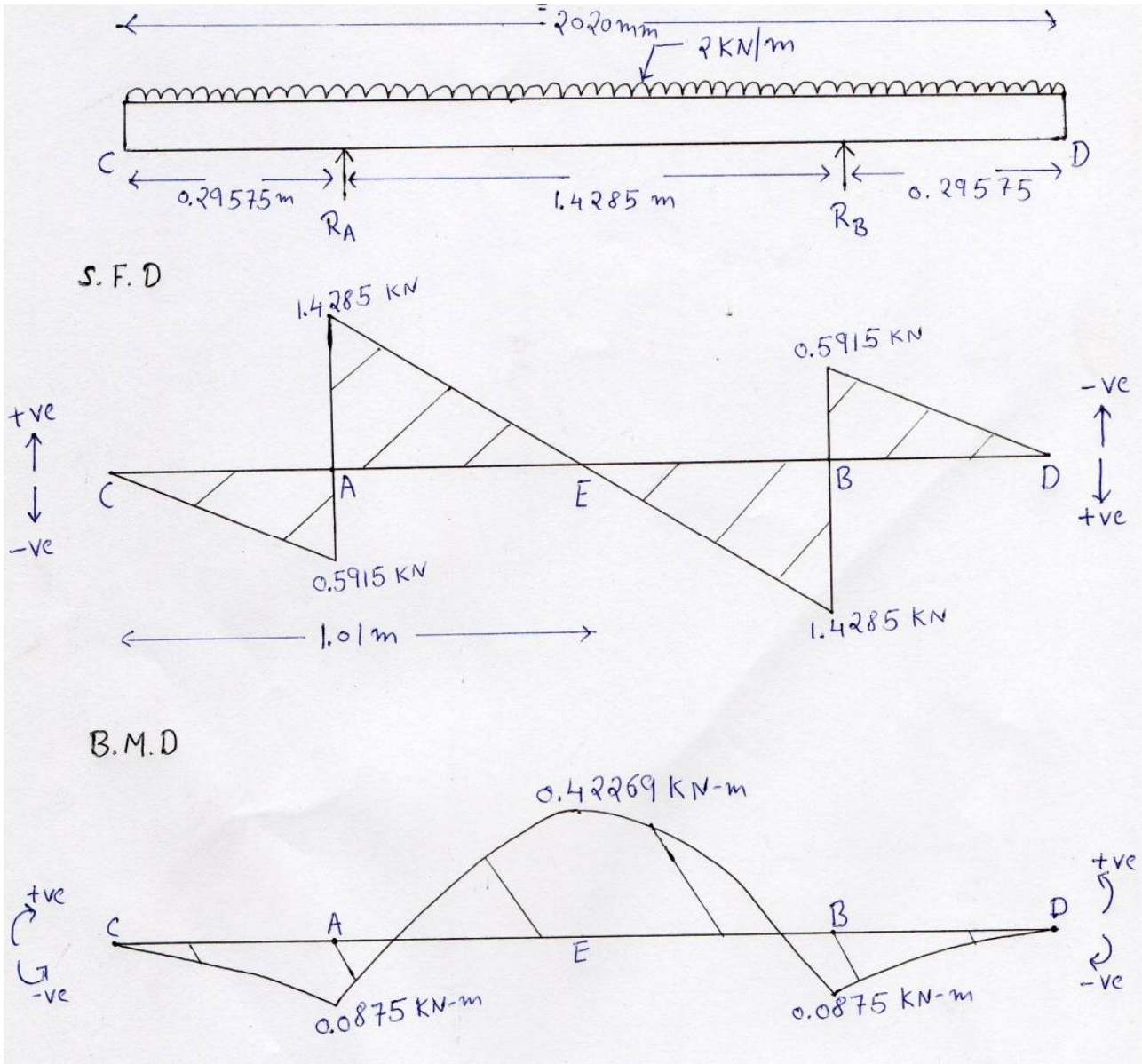
(a)

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## VIII. DESIGN BY S.F.D & B.M.D



$$M_{MAX} = WL/8 = (2 \times 2.02) \times (2.02) / 8 = 1.0201 \text{ KN-m}$$

$$I = (\pi/64) \times (D_o^4 - D_i^4) = \{(0.0254)^4 - (0.0224)^4\} = 8.0733 \times 10^{-9} \text{ m}^4$$

$$Y_{MAX} = 5 \times (WL^3) / (384 \times EI) = (5 \times 2 \times 2.02 \times 2.02^3) / (384 \times 200 \times 10^6 \times 8.0733 \times 10^{-9}) = 0.2685 \text{ m}$$

**IX. ANALYSIS RESULT**

Fig. 3 shows finite element analysis of original existing industrial model (a) Boundary condition & Loading condition of existing model (b) Displacement of existing model - 10.7 mm (c) Vonmises stress of existing model - 320 MPa

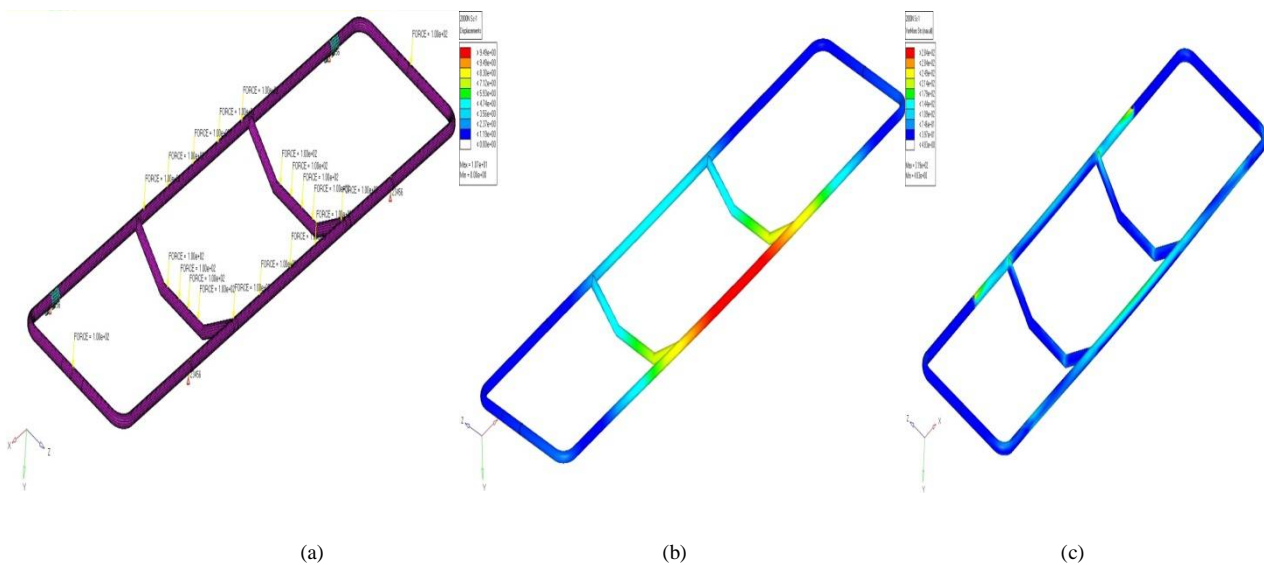
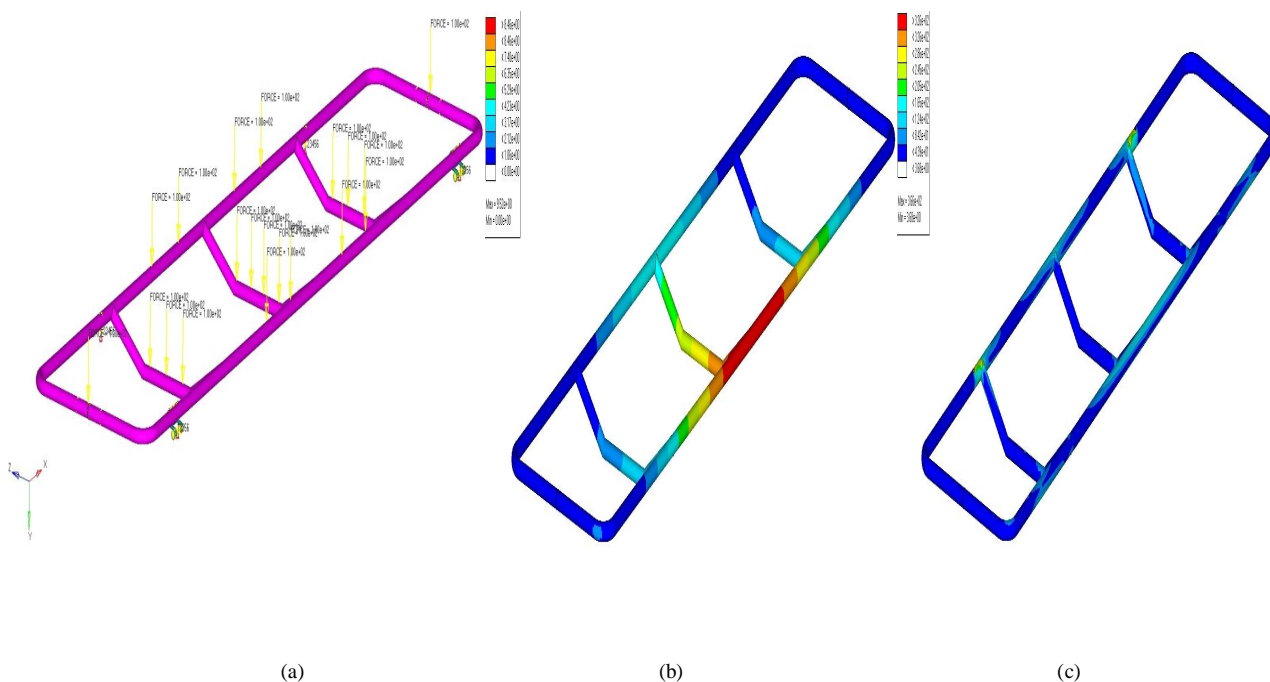


Fig. 4 shows finite element analysis of final optimized model (a) Boundary condition & Loading condition of optimized model (b) Displacement of Optimized model-9.5 mm (c) Vonmises stress of optimized model - 366 MPa



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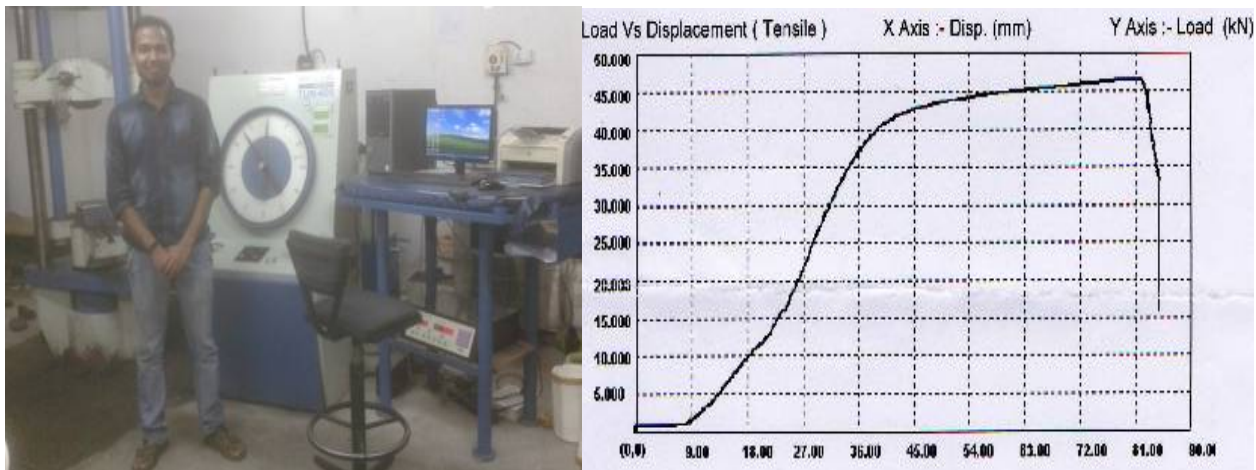
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MODEL	DEFLECTION (in mm)	VONMISES STRESS (in MPa)	WEIGHT(Kg)
EXISTING	10.7	320	7.5
MODIFIED	10.8	326	5.6
FINAL OPTIMIZED	9.5	366	5.5

## X. EXPERIMENTAL RESULTS

Fig. 5 shows the experimental results of tensile and bending test done in M.I.A lab, Nagpur by universal testing machine (a) M.I.A lab (b) Graph of load v/s displacement during tensile test (c) Sample result value



<b>MIA TEST LAB &amp; RESEARCH CENTRE</b>					
MIA House, P 26, MIDC Hingna Area, Nagpur - 440 028. Office : (07104) 234256 Mob.: 9423102900, 9370287714/15 Fax: (07104) 236138. Email : miatestlab@gmail.com Website : www.mianagpur.com					
<b>TEST REPORT</b>					
TL-M/401					
Date : 18/06/2016					
Page : 01 of 01					
Name & address of customer : M/s. Abhijit N. Roy; Sadar, Nagpur.					
Your reference no. :- Letter dated 18/06/2016.			Sample received on :- 18/06/2016		
Our reference no. :- S.R.L.F. No. M-178 dated 18/06/2016			Test carried out on :- 18/06/2016		
Method Used : IS 1608:2005/1599:2012.					
Sr. No.	Samples Identity	YS N/mm <sup>2</sup>	UTS N/mm <sup>2</sup>	Gauge length by 50mm % El	Bend Test
01	SS2522 (T)	484.562	592.498	7.50	---
02	SS2522 (B)	---	---	---	Satisfactory
Remark:- Test Witnessed by Mr. Abhijit Roy					

(c)

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## XI. CONCLUSION

Thus reduction in manufacturing cost of industry is gained and an efficient model with good strength of material having high breaking point value is achieved. These improve weight holding capacity and comfort, which ultimately improve life of berth. As this is mass production equipment, the effective cost saving will be around INR150-160 per product by these optimization which is significantly benefit to the supplier in long term in ton over production.

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