Modelling and Analysis of MSRTC Aluminum Bus Structure Joints

#1Mangesh Mhaske, #2A.D.Desai, #3Sushant Hiremath

1mangesh206@gmail.com, 2ad.desai711@gmail.com, 3hiremathsushant24@gmail.com

1Department of mechanical engineering
Shree Ramchandra College of Engineering, Pune, India

1Department of mechanical engineering, Savitribai Phule Pune University
Parvatibai Genba Moze College of Engineering, Pune, India

3Asst Prof at Dhole Patil College of Engineering,
Department of Automobie Engineering, Savitribai Phule Pune University

ABSTRACT
The MSRTC bus structure has of Aluminum skeleton inside sheet metal, and it consists of vertical pillars and horizontal waist rails, portion between this is called as bay. This study focuses on basic structure with dynamic condition. The pillar and waist rail joint are connected by means of Aluminum riveted cleats to waist rail and bolted to pillar, so its mechanical strength is good in static condition but when vehicle faces situation like acceleration, deceleration, braking, overloading etc. fails to remain rigid and riveted joints become loose. It is therefore necessary to modify it as it should be suitable for production as well as cost effective and at the same time sturdy.

Keywords— MSRTC Bus Structure, Joint Design, CATIA V5, ANSYS.

I. INTRODUCTION
MSRTC manufacturing buses for public transport which are manufactured in central workshops and hand over to divisional depots. So main focus is to manufacture bus in low cost and high life durability is first priority of mechanical department. Standard materials of construction correspond with AIS-052 material classes Al, MS.

II. BUS MANUFACTURING
Final assembly is done at bays provided at workshops here bus passes through Frame construction
1. Chassis preparation
Initially the MSRTC purchases TATA and Ashok Leyland chassis with front cowl and engine hood. These chassis are manufactured with somewhat extra front as well as rear overhang. Horizontal guarders of M.S having C cross section are mounted with the help U bolts.
2. Side and front framing
For side framing corporation uses hat section of BIS 733/1983 having Aluminum alloy material.
3. Roof framing and rear end
Same material used with bended corners which are manufactured in bending machine.
4. General inspection
After the preparation of bus skeleton supervisor inspects joints and straightness of the structure.
5. Flooring and interior lining
Flooring material is the thick Aluminum checkered sheets. These sheets are bolted to base M.S structure.
6. Roof panels
Roof paneling done in sequence as it starts from side and ends in the center. Generally pop and blind rivets are used for fastening these Aluminum sheets.
7. Paneling and molding
Side paneling and door mounting done at this stage. Here also they uses pop and blind rivets at specified spots.
8. Painting and Accessories

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Without any application level finishing putty materials these buses is painted by base primer coat and then final touch up with colour specified by stat transport ministry.

9. Final finishing
Fully equipped bus with seats and all other accessories is tested visually and send for final testing.

TESTING
All testing of buses is done as per AIS code. These tests as follows:
1. Leak test
2. Shallow water test
3. Vibration test
4. Visual inspection
5. On road performance* (Brake test, acceleration, grad ability, economy)

III. LITERATURE REVIEW
MSRTC is the second largest Corporation in the Transport Sector. ME Department is the main important segment operating and maintaining fleet of about 16,000 buses and making them available for operation throughout Maharashtra. This Department works on two fragments viz. production and operation and for this purpose it has got network of depots, Divisional Workshops. Body building works on new chassis are done in the 3 Central Workshops i.e. Pune, Aurangabad and Nagpur. As mentioned, for production of new buses and maintenance of buses, ME Department has got 3 tier system i.e. Central Workshops, Divisional Workshops and depots.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Central Workshop</th>
<th>Man hours prescribed per bus (in minutes)</th>
<th>Production capacity per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pune</td>
<td>1150</td>
<td>756</td>
</tr>
<tr>
<td>2</td>
<td>Aurangabad</td>
<td>1122</td>
<td>720</td>
</tr>
<tr>
<td>3</td>
<td>Nagpur</td>
<td>1112</td>
<td>730</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>3384</td>
<td>1836</td>
</tr>
</tbody>
</table>

IV. METHOD OF OPERATION
1) Objective of this Project is to prepare model of MSRTC aluminum bus structure joints to study their strength for different road conditions. It was observed from Acceleration, Deceleration, on Grades and Slopes, Crash scenarios that bus structure get weaken at particular bay at various joints whereas most of the sections remained unaffected. Using these loading conditions critical joints were analyzed independently for getting insights into relatively weak and unstressed regions. For linear analysis we supposed to use ANSYS to carry out virtual simulations. Aluminum bus structure joints were modeling using CATIA and linear analysis we supposed to use ANSYS was used to carry out virtual simulations. For Post processing we follow ANSYS.

V. PROPOSED WORK
PROJECT OBJECTIVES

Following objectives are proposed to follow during analysis of joint strength.
a) Static Structural analysis of complete aluminum bus structure to get exact load cases and boundary conditions for micro level joints optimization.
b) Modal analysis using the above loading conditions to analyze the natural frequency at various joints independently for getting insights into relatively weak and strong regions

A. Proposed Softwares for project work:
   • 3D CAD modeling: CATIA
   • FE modeling (Meshing): ANSYS 14.5
   • FE analysis (Solver): ANSYS 14.5
   • Post processing: ANSYS 14.5

B. Baseline Design

TABLE II

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Material</th>
<th>Young’s Modulus (GPa)</th>
<th>Poisson’s Ratio</th>
<th>Density (g/cc)</th>
<th>Yield Stress (Mpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mild Steel</td>
<td>210</td>
<td>0.3</td>
<td>7.86</td>
<td>250</td>
</tr>
<tr>
<td>2</td>
<td>Aluminum</td>
<td>71.4</td>
<td>0.33</td>
<td>2.7</td>
<td>270</td>
</tr>
</tbody>
</table>

At present MSRTC using material for pillar and beam section is Aluminum. Linear material properties of Aluminum are as follows.

Fig.2 shows typical pillar to waist rail joint

VI. FINITE ELEMENT ANALYSIS

1. Discretization
In this we convert main body into number elements for sophisticated solution.

TABLE III

Meshing Statistics
Nodes 86083  
Elements 40377  
Mesh type Tetrahedron

2. **Boundary Conditions**
   For any solution in FEA we require number of boundary conditions. So first fix the body and then apply the forces for post processing.

3. **Total Deformation**
   As observing image of ANSYS solution of deformation, we can get exact location of deformation at the loaded body.

4. **Von Mises (Yield) Stress**
   Von mises stress defines the maximum yielding stress at the particular location which useful before manufacturing in actual practice.

5. **Safety Factor**
   The project mainly focuses on joint study and safety factor plays an important role as deciding factor for thickness of material.

6. **Modal Analysis**
   As all of we know each and every thing on planet has its own Natural frequencies which differ from each other. In FEA we find these frequencies for omitting resonance in the body.

VII. **RESULTS AND DISCUSSIONS**
   Maximum deformation due tensile forces 1.2364 mm at the center of the joint as compare to remaining places are comparatively less. Need to reinforce.
   Maximum Von mises stresses found in cleat region 390 MPa which is observed near the fillet region. Maximum von mises stress indicates that rivets will first start yielding rather than nut bolt assembly which stronger. As it will fail the whole structure due cleat failure. Whereas the pillar is safe at given load and boundary conditions.
   Maximum factor of safety is 5 at pillar region as compared to minimum is 0.64056 at near cleat fillet and reinforcement region.
Maximum natural frequency found for the structure is 226 Hz at waist rail region as it is not isolated from other structure, but if we use elastomer between cleat and pillar it will absorb the vibration.

VIII. CONCLUSION
From the above theoretical and analytical study we can conclude that
The current 2×2 MSRTC ordinary bus structure is weaken at base skeleton.
Pre stressed waist rail cause uneven vibrations in the passenger compartment. The natural frequency of structure is equal to the excitation frequency generated by transmission and road undulations. It is required to build stress free structure.
Due to higher yield stress in material it is essential to change material and its thickness as it can cause failure after certain structure life.
As we study fatigue on primary bases at static level but it is serious issue at dynamic state, so need to lower fatigue damage by improvising increase in strength and ductility of current BIS material.

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