ABSTRACT

Wheels are one of the most critical components in automotive engineering. Their function is of vital importance to human safety. Wheels are components working under cyclic loading and different load spectrum considering the load amplitude and frequency. Disc wheels intended for normal use on passenger cars have to pass three tests before going into production: the dynamic cornering fatigue test, the dynamic radial fatigue test, and the impact test. Fatigue prediction has been an important issue in the design of aluminum disc wheels. Wheels are clearly safety related components and hence fatigue performance and the state of stress in the rim under various loading conditions are prime concerns. Further, wheels continue to receive a considerable amount of attention as part of industry efforts to reduce weight through material substitution and down gauging.

INTRODUCTION

In the fatigue life evaluation of steel wheel design, the commonly accepted procedure for passenger car wheel manufacturing is to pass two durability tests, namely the radial fatigue test and cornering fatigue test.

It is difficult to assess fatigue life by using analytical methods. In general, the newly designed wheel is tested in laboratory for its life through an accelerated fatigue test before the actual production starts. Based on these test results the wheel design is further modified for high strength and less weight, if required.

The necessary material data for fatigue life prediction with the stress concept is the well known S–N curve. Therefore, S–N curves are required for each specimen which reflects the stress condition in the critical area of the component.

LITERATURE SURVEY

Carvalho et al [1] Wheels are components working under cyclic loading and different load spectrum considering the load amplitude and frequency. Based on the different manufacturing process on evaluation of fatigue life prediction can take account using tests. The flow-forming process help the hardness improvement on the disc material and the results is the improvement on fatigue life. A wheel works under a load spectrum where the load amplitude and frequency can change depend on the vehicle characteristics, road, tire used. Wheel designation & nomenclature specification some norms exist at TRA, ETRTO, and ALAPA.

Table1: Cast Aluminium Alloy A356 Properties [2]

<table>
<thead>
<tr>
<th>Nominal Chemical Composition</th>
<th>Mechanical Properties in Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon (Si) - 6.5 - 7.5%</td>
<td>Youngs Modulus - 6.895 Gpa (106 psi)</td>
</tr>
<tr>
<td>Copper (Cu) - 0.10%</td>
<td>Yield Strength - 20.7 Mpa (30,000 psi)</td>
</tr>
<tr>
<td>Magnesium (Mn) - 0.30 - 0.45%</td>
<td>Magnesium (Mn) - 0.30 - 0.45% Poissons ratio - 0.32</td>
</tr>
<tr>
<td>Manganese (Mg) - 0.05%</td>
<td>Ultimate strength - 25.795 Mpa (40 ksi)</td>
</tr>
<tr>
<td>Zinc (Zn) - 0.05% max</td>
<td>Hardness (BHN) – 75</td>
</tr>
<tr>
<td>Titanium (Ti) - 0.20% max</td>
<td>Elongation 6% in 2 inch gauge length</td>
</tr>
<tr>
<td>Others each - 0.05%</td>
<td></td>
</tr>
<tr>
<td>Others Total - 0.15%</td>
<td></td>
</tr>
</tbody>
</table>

Kocabicak et al [3] in automotive engineering the wheels are one of the most critical components and their functions is of the vital importance in human safety. The wheel manufacturers have been taking increasing attention to light weight designs by new materials and manufacturing technologies. Knowing that and the requirements iterations must be reduced at the physical prototype level and increased during virtual prototyping with a reliable methodology to predict the durability parameters such as fatigue life. In the fatigue evaluation of a wheel design the commonly accepted procedure for wheel manufacturers is to pass two durability tests, namely the radial fatigue test & the cornering test. LBF Germany has designed the biaxial wheel fatigue test.
and its test machine. Elasto plastic stress-strain also affects on fatigue life.

The stress distribution in a wheel depends on the mode of operation and the stress at any point in the wheel is composed of prestresses and service stresses. The stress due to the manufacturing processes, tire pressure and assembly to the hub are the prestress on the wheel. The service stresses are result of the wheel loads which are the vertical force, lateral force, longitudinal force, vehicle weight and dynamic forces. The highly stressed region in a disk type wheel are the rim well, weld zone between disk and cooling holes, bolt contact area and hat radius.

**Akbulut et al** [4] Rims are the most vital elements in a vehicle, they must be designed carefully. The rim type examined in this study has some trouble when touching any curb or entering a sharp curve. The rims manufactured by various methods are made of either steel or cast aluminum alloys. By doing FE analysis of elasto plastic tress strain the optimization of car rim takes place.

**Ramamurty Raju et al** [8] In the fatigue life evaluation of aluminum wheel design, the commonly accepted procedure for passenger car wheel manufacturing is to pass two durability tests, namely the radial fatigue test and cornering fatigue test There are different loading methodologies for simulation of radial fatigue test. The dynamic nature of the tests is simulated using equivalent static load in the form of cyclic nature. The present work deals with estimating the fatigue life of aluminum alloy wheel by conducting the tests under radial fatigue load and comparison of the same with that of finite element analysis. Fatigue life prediction using the stress approach is mostly based on local stress, because it is not possible to determine nominal stress for the individual critical areas. The necessary material data for fatigue life prediction with the stress concept is the well known S–N curve.

**REFERENCES**


**CONCLUDING REMARK**

From the above literature survey we conclude that

1. There are various methods are available on evaluation of fatigue life of wheel rim.
2. However the less work is done with modal analysis on evaluation of fatigue life of wheel rim.
3. So the proposed work will carried out on
   - To investigate the effects tire pressure variation in conjunction with the radial load on the stress and displacement in tire rims, through finite element analysis.
   - To investigate the effect of various design of tire on fatigue life of wheel rim using finite element analysis.

**Fig2: Highly Stress region**

**Fig3: S–N curve of A356.2 material.**

**Fig4: Applicable pressure ranges for Fuji Pre-scale Films**

**Sande et al** [46] a Fuji pre-scale film consist of microcapsules filled with color forming material. An applied pressure depending on the value of this pressure will break these microcapsules. When a microcapsule is broken the color forming material is released. This material reacts with a color developing material and the magenta color will be formed. With the Fuji pre-scale films an external pressure measurement and a momentary pressure measurement can be done.

The films are available in two possible formats. One format is based on two sheets. The other is based on a single sheet. The film types MS (Medium pressure) and HS (High pressure) are Single sheet layered types. The other Fuji film types are two sheet layered types.

The time to test and inspect wheel during development is very consuming. For economic reasons, it is important to reduce the time spending in trial and error during the development and testing phase of a new wheel. Computer simulation of wheel tests can significantly reduce the time and cost required to finalize a wheel design. The simulations of rotating bending test and radial fatigue test have shown good agreement with experimental results.


6. Bram van de Sande "Assessment of Fuji Pre-scale films in tire/road contact surface measurements" (s040433)IDCT 2007,pp083