SPOT WELD OPTIMIZATION IN WHEEL RIM

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Abstract: After manufacturing of rim and disc they are press fitted together after press fitting they are spot welded with the help of 24 weld spots having nugget diameter as 8mm. The objective of the experimental verification is to reduce the number of spot weld without affecting the fatigue life of a wheel to improve productivity. The FEA is done for 24 spot weld rim and validated by cornering fatigue test after that for optimization different combination of spot welds has been proposed and there FEA analysis is carried out and FEA results are compared with standards and validated by experimental method on Cornering Fatigue Test.

Key Words: Spots,Rim,FEA,Cornering, Fatigue Test.

Objective:

Scope of this project is to optimize the number of spot welds by FEA and validate the solutions as per test criteria.The main objectives of this project are

1.For the same fatigue life to optimize the number of spot welds.

2.Reduced manufacturing cost and improve productivity.

Methodology:

Approach from problem definition to solution implementation. Following is the methodology of this project work.

1. Finite element method
2. Experimental method.

Before starting analysis it is important to understand current process. Literature review was carried out to understand past work carried out in field stress analysis of wheel rim. To validate the solution following methodology was adopted. Experimental study of proposed solution was planned as per following tests.

1.Finite element analysis of 24 spot weld rim for cornering fatigue test

2.First 3D model was designed with the help of CATIA and this model was imported in a Ansys after that Finite element analysis is carried out to find the fatigue life of a wheel for the cornering fatigue test.

3.Experimentation- Cornering fatigue test.

4.A cornering fatigue test is carried out on cornering fatigue test rig as per the steps mentioned in standard procedure and fatigue life of 24 weld spot rim is determined.

5.The FEA result of 24 weld spot rim is compare with Cornering fatigue test result and validation is done.

6.After that different combination of spot weld was proposed .The different combination of spot weld were 21, 18, 15 and Finite element analysis for proposed scheme were carried out. Then Finite element analysis of proposed scheme was compared with standards and solution was obtained.

7.FEA analysis of obtained solution for static pressure test.

8.After obtaining solution the proposed combination was checked for static pressure and radial load. Analysis was carried out for proposed work under different combination of pressure and radial loads to check the effect of pressure and radial load on the rim.

9.An experiment is carried out on 24 spot weld rim under the different combination of tire air pressure and radial load to know the effect of pressure and radial load on the rim.

10.After experimental study conclusions were drawn and solution is selected for to improve the productivity of the wheel rim and to reduce the manufacturing cost.

Finite Element Analysis:

The Finite Element Method produces numerous synchronous arithmetical mathematical statements, which are created and understood in FEA bundle. The FEM is utilized for anxiety examination is an effective and investigation device. FEM or FEA has wide degree in outlining and examination field structure mechanical to electrical. FEA gives an answer for the errand of showing so as to foresee disappointment because of obscure burdens issue zones in a material and permitting planners to see the greater part of the hypothetical hassles within.FEA comprises of a PC model of a material or configuration that is focused and broke down for particular results. It is utilized as a part of new item plan, and existing item refinement. . If there should arise an occurrence of auxiliary disappointment, FEA might be utilized to decide the outline changes to meet the new condition. FEA utilizes a mind boggling arrangement of focuses called hubs, which make a framework called a cross section. This cross section is modified to contain the material and auxiliary properties, which characterize how the structure will respond to certain stacking.

In this project it is used to determine the life, safety and damage of the current design of wheel having 24 spot welds.

Modeling Of Wheel Rim:

CATIA V5R19

It can be efficiently used for modeling complex parts, features and assemblies. The wheel rim is one such complex component which can be easily modeled using CATIA Model.

Fig.1. 3D Model of Wheel Rim

Analysis of a Wheel Rim With 24 Weld Spots

Toolfor FEA :ANSYS R 15

ANSYS Workbench conveys numerous new potential outcomes to the ANSYS AUTODYN client as far as CAD geometry import, complex geometry era, lattice and convenience. To supplement the essentially improved model era abilities, a scope of new solver, material demonstrating and post-handling highlights empower bigger recreations to be illuminated in a speedier time.

ANSYS Inc created and looks after ANSYS, a broadly useful limited component displaying bundle for numerically tackling static/dynamic auxiliary investigation (both straight and nonlinear), liquid and warmth exchange issues and additionally electromagnetic and acoustic issues.

Mesh View

The total number of nodes and elements is 58692 and 30095 respectively.

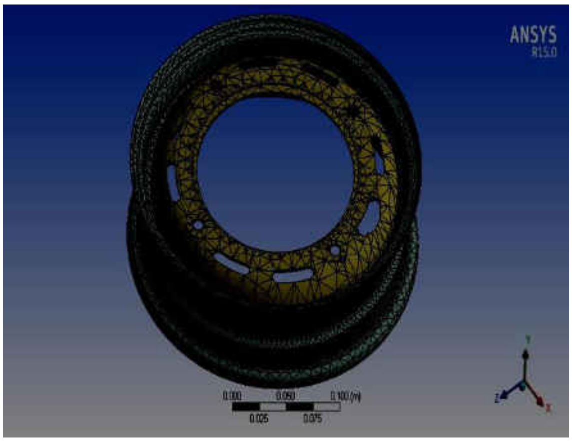


Fig.2. Mesh View of RIM

Boundary Conditions:

The boundary conditions applied for wheel rim are shown in following figure 4.4.The boundary conditions are explained with the help of a loading. In a cornering fatigue test aconstant bending moment is applied on a wheel rim. In this set up rim without tire is fitted on a rotating table and four bolts are fitted in a bolt holes. In a boundary condition a force of 110 N shows the weight of a shaft and assembly. In this case total 5 boundary conditions are applied four moments and reaming is the force.

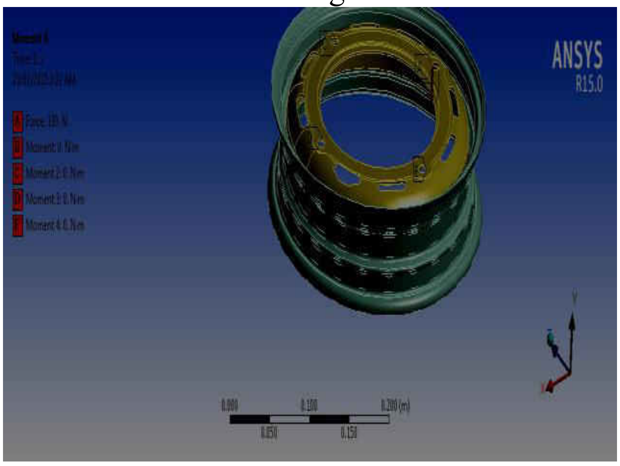


Fig.3.Boundary Conditions applied on Rim

The bending moment is calculated as follows :$B.M = F_R d + F_L R$

$= F_R d + \mu F_R R$

Where F_R=Radial force acting on the wheel=206 Kg

d=wheel offset=0.126

μ=Coefficient of friction between ground and tire=0.7

R=Radius of statically loaded tire mounted on the wheel=0.203 m

B.M=54 Kgm

Wheel Rim Material: Steel-

As the volume of passenger cars increased the only material and method of manufacture that could provide an economic wheel was the disc wheel formed from hot sheet rolled. The rim was made by roll forming a flash butt-welded hoop. Mechanically caped SAE 1008 and 1010 grades were the typical rim materials. Mechanically caped steel provides higher usable metal yield from ingot and more uniform chemical through the thickness of the sheet which improved the butt weld ability. Rimmed steel in SAE grade 1012 and 1015 were used for the disc because on hot rolled sheet that was very low in alloy content. In the early 1950's the tubeless tires were introduced and they added challenge for the wheel maker the rim had to be air tight. It was difficult to insure that air leakage would not occur around the rivet so other methods of attaching the rim to the disc were investigated and the resistance spot weld and the arc weld attachments were developed. The spot weld was initially favored because it was very similar in function to a rivet, and no material had to be added to added to the weld joint. The desire for lighter, more fuel efficient vehicle resulted in changing from rear wheel drive to front drive. This necessitated designing the wheel with much deeper disc to clear the front drive mechanism. The deeper disc increased the stresses so that heavier stock was required to provide adequate fatigue performance.

Steel Grade	Properties		
C1008	TYS 206700KPa	TS 310050KPa	%E 30

Table.1. Material Properties

Fatigue life of Wheel Rim With 24 Weld Spot

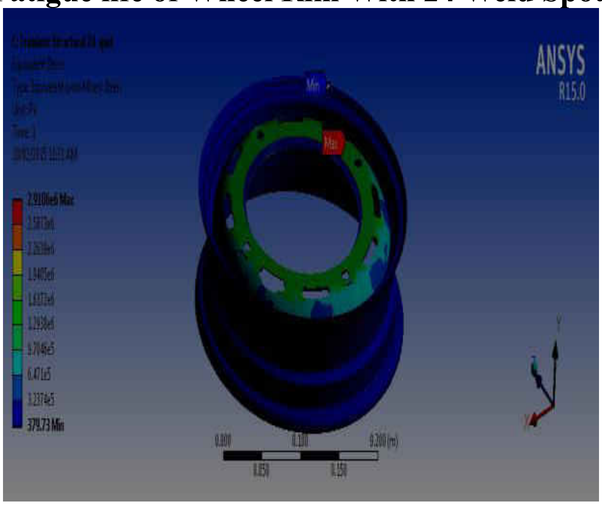


Fig.4. FEA of rim

Finite Element Analysis of Rim with 24 spot welds

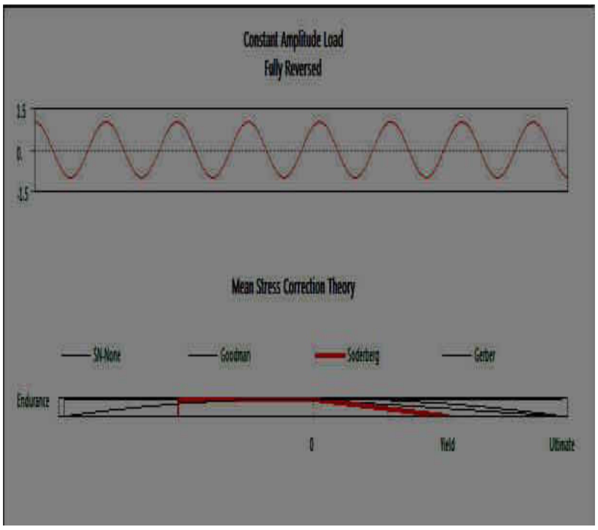


Fig.5.Fatigue life of rim

FEA Results for 24 Spots:

Equivalent stress		Equivalent elastic strain		Life Cycles
Max Pa	Min Pa	Max (mm/mm)	Min (mm/mm)	
$2.91*10^6$	379.73	$1.96*10^{-5}$	$5.11*10^{-9}$	$1*10^6$

Table:2.Stresses in Rim

Validation For Cornering Fatigue Test

For the purpose of validation the physical known as cornering fatigue test is carried out and discussed below.

Dynamic Cornering Fatigue Test

The cornering fatigue test is a standard SAE test, which reenacts cornering prompted burdens to the wheel. Fig 5.1 demonstrates the test framework in which the test wheel is mounted to the pivoting table, the minute arm is altered to the wheel external mounting cushion with the fasteners and a consistent power is connected at the tip existing apart from everything else arm by the stacking actuator and bearing, along these lines bestowing a steady turning bowing minute to the wheel. On the off chance that the wheel breezes through the element cornering weakness test, it has a decent risk of finishing all other required toughness tests.

After fulfillment of the test the test example is expelled from the set up. At that point by visual investigation the breaks are watched. On the off chance that breaks are outwardly not seen then the color penetrant test is utilized to distinguish the split.

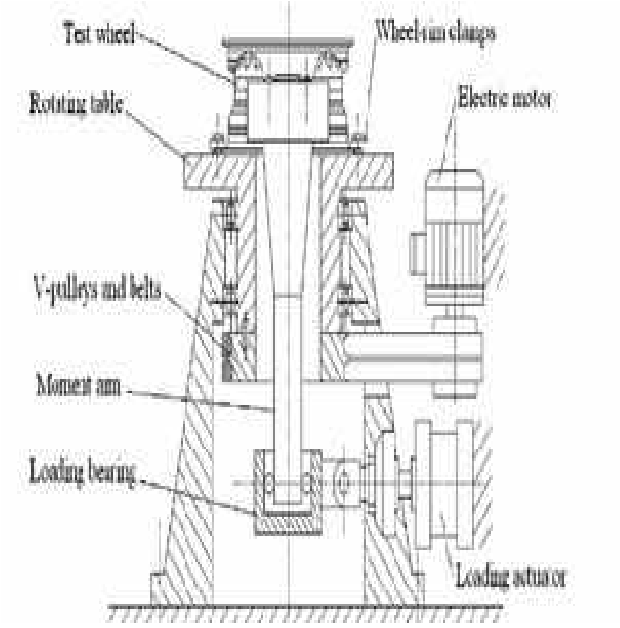


Fig.6.Cornering Fatigue Test

Result Comparison

From comparison it is clear that, life of wheel in FEA and experiment is same. Therefore validation of CFT is done.

Parameter	FEA (Cycles)	Experiment (Cycles)
Life	$1*10^6$	$1*10^6$

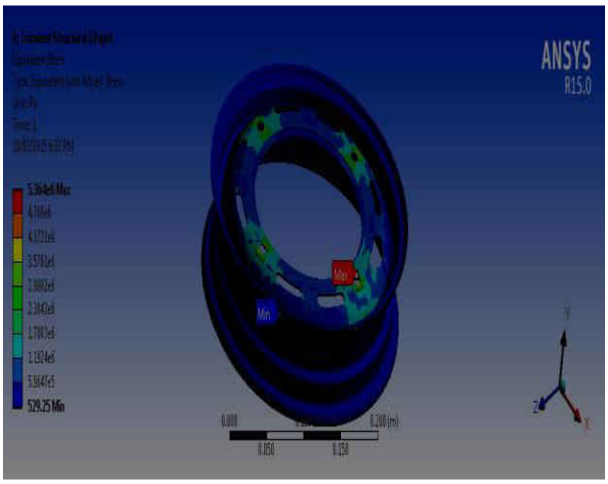
Table 3. Experimental and FEA Results

Optimization Of Weld Numbers

For optimization purpose following combinations has been proposed

1. 21 spot weld
2. 18 spot weld
3. 15 spot weld

FEA Analysis of Proposed Scheme



Analysis of A Wheel Rim With 18 Spot Weld:

Fig7.a.FEA of 18 spots rim

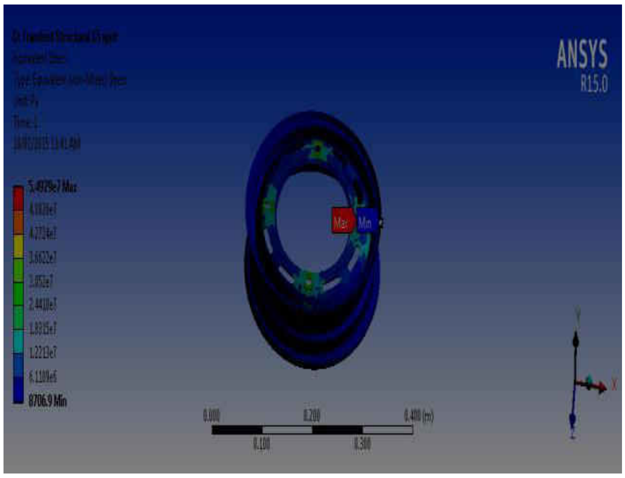


Fig7.b.FEA of 18 spots rim

Discussion of Results

Spots	Equivalent Stress(Pa)		Equivalent Elastic Strain (mm/mm)		Life Cycles
	Max	Min	Max	Min	
21	$5.2827*10^6$	479.73	$1.9622*10^{-5}$	$5.1145*10^{-9}$	$1*10^6$
18	$5.364*10^6$	528.25	$2.6742*10^{-5}$	$2.3445*10^{-8}$	$1*10^6$
15	$5.4929*10^7$	8706.9	$2.7605*10^{-4}$	$1.8632*10^{-7}$	$2.47*10^5$

From results of the proposed scheme and experimentation it is clear that 18 spot weld rim gave same fatigue life as that of 24 weld spot so for further work 18 spot weld rim is considered.

Conclusion:

By use of FEA method we optimize the number of spots from 24 to 18 and validated using Dynamic cornering fatigue Test.

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