ARAŞTIRMA, GELİŞTİRME VE UYGULAMA MAKALELERİ

A Study on Endurance of Aluminum Road Wheels Produced by Flow Forming for Tracked Land Platforms

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Conventional road wheels for defense vehicles are generally produced by steel material easily and cheaply, but it brings extra, undesirable weight to the platforms. It is found that the use of aluminum for road wheels provides weight reduction on tracked land platforms. Generally, common manufacturing techniques for aluminum road wheels are casting and forging. These methods may not be suitable due to absorbing capability and cost perspective respectively. In this study, road wheels made of aluminum alloy material (2014-T6) produced by flow forming method as an alternative to steel is subjected to stress and fatigue analysis numerically and experimentally. It was concluded that flow forming production method of aluminum road wheel would be suitable method to provide required low cycle fatigue life with advantageous of cheapness and lightness

Keywords: Flow forming, road wheel, tracked platform, finite element method, stress analysis, fatigue analysis

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INTRODUCTION

The performance of military vehicles on the battlefield can greatly affect the outcome of the war. Therefore, there are a number of important issues to be considered in military vehicles. One of these is to reduce the weight of military vehicles, which is a matter of considerable importance by military vehicle manufacturers [1, 2].

The road wheels are an important part of the military vehicles such as tanks and self-propelled howitzers and they are used in a lot of fields of defense land systems. In general, these road wheels are produced by steel alloy material due to its cheapness and availability. On the other hand, reduction of vehicle weight has vital importance in the transportability and mobility of modern warfare equipment. Therefore, much effort is being expended to develop lightweight road wheels. Cast or forged aluminum with magnesium alloy road wheels are being used successfully by some tracked vehicles nowadays [3, 4, 5].

Definitely, there are significant properties of aluminum alloy wheels that they have low weight, high strength values, high toughness and high fatigue resistance. Generally, common manufacturing techniques for aluminum alloy road wheels are casting and forging [6]. Since load spectrum that each tracked vehicle road wheel experiences is considerably high and dynamic, casting may not be a good solution for manufacturing due to lower load absorbing capability of cast products. On the other hand, forging might be a suitable method for dynamically loaded road wheels but, it is also expensive as well due to mold and final machining cost. Therefore, another method known as flow forming method was utilized for effective, cheap and lighter production in this study [5, 7, 8]. The military road wheels are generally subjected to different types of static, dynamic loads and impacts during their lifetime. Since these wheels are subjected to various fatigue loads, fatigue tests have great importance. So, main focus was put to see the effect of flow forming method on low cycle fatigue behavior of aluminum made road wheels [9-13].

In this study, the low-cycle fatigue behavior of the aluminum alloy road wheels produced by flow forming method using Al 2014–T6 material, considering the minimum and maximum compression loads experienced by a 47 tones tracked land platform on the road wheel, is investigated. Numerical and experimental fatigue analyses for only radial dynamic compression loads (excluding bending loads) were performed and the results together with the fatigue life data obtained by using the known S-N diagram of the material which is used Al 2014 – T6 is commented. Thus, it is intended to determine the fatigue safe life of each road wheel manufactured by flow forming method under specified loading conditions. In order to determine the fatigue safe life of the aluminum alloy road wheel (Al 2014 – T6) which has the same existing steel solid model geometry under the identical load spectrum, test coupons were cut and prepared for fatigue test from a prototype road wheels.

The main goal of this study is to investigate the low cycle fatigue life of aluminum 2014 – T6 road wheel which is manufactured by flow forming method for a 47 tones tracked armored vehicle and show the weight advantage of it by comparing with the steel equivalent road wheel.

Road Wheels

Military tracked vehicles can be moved by aid of the road wheels which are located at the bottom hull of the vehicle, see Figure 1. They are sometimes referred to as bogie wheels. Material itself and design criteria of road wheels affect significantly the abilities of tracked vehicles.

The number of the road wheels is determined according to total combat weight of the vehicle. When numbers of road wheels are calculated for a typical main battle tank, the total combat weight of main battle tank has to be considered. Since total weight is 47 tones, the design consists of six dual 26” road wheels on each side. If uniform load distribution is assumed, each dual wheel supports approximately 3,8 tones. However, the loading of the road wheels may not be uniform under static conditions due to the location of the center of gravity. [11]

Figure 1. Military Tracked Vehicle Road Wheels

When the number of road wheels is increased, suspension efficiency of the vehicle is decreased. Decreasing of efficiency may be outweighed by other advantages. There are two types of fundamental design concept in the diameter of the road wheel. Those are rolling resistance and power lost concepts as a result of the track link striking the ground. Some researches show that when the diameter of the road wheel is increased without changing its geometry, sinkage and rolling resistance are improved positively [11].

Generally, material of road wheels is steel and disk type of road wheels includes riveted or welded construction parts. On the other hand, cast or forged aluminum with magnesium alloy road wheels are also being used successfully by some tracked vehicles nowadays. The fatigue life of these materials can be provided by careful design, fabrication and surface treatment. [2, 12]

The aluminum alloy road wheel of the aforementioned land platform is manufactured by flow forming method which is also called spin forming. This manufacturing method is used in automobile road wheels mostly. Flow forming is a kind of sheet metal forming process. When circularly cut sheet metal is rotated around its radial axis, it is shaped by applying radial and axial force gradually on mandrel which is a kind of mold with the aid of rotating wheels. The advantages of flow forming method are material saving; close dimensional accuracy, low mold cost, high production quantities and hardening of materials. When flow forming method is used in production of road wheels, mechanical properties of road wheel such as strain hardening and fatigue strength increase considerably so road wheels can have higher bearing capacity. Considering these advantages, this process is chosen as the most suitable manufacturing method [5, 11].

MATERIAL SPECIFICATIONS

When density characteristic of steel and aluminum are compared to each other, aluminum has 2,7 g/cm3 and steel has 7,85 g/cm3 Therefore, there is approximately three times difference in weight between them, hence aluminum is preferred in this comparison due to lightweight characteristics. When high strength of aluminum alloys is combined with light weight characteristic, it allows to design and produce of strong and lightweight structures. Especially, this advantageous is effective for moving vehicles such as spacecraft, aircraft, and all types of land and watercraft vehicles [9].

Road wheel originally made by forged steel of a heavy tracked platform was manufactured by 2014 - T6 aluminum alloy material in this case. This material can be used easily for the applications that are requiring high strength and hardness. 2000 series aluminum alloys are effective in damage tolerance applications and also they have higher temperature working capability. It was reported in literature [11] that after T6 heat treatment, yield strength of road wheel was 380 MPa, tensile strength was 440 MPa and elongation was %10. These values were used as aluminum material properties in stress analysis with finite element method.

NUMERICAL ANALYSIS

Finite element model of road wheel was generated by using ANSYS 16.0 Workbench software which provides a solving method by finite element analysis more quickly and facilitates making a correct decision. Firstly, boundary conditions such as forces, supports and friction coefficient were assigned to software to start analysis. Secondly, stress distribution of the total road wheel has been obtained. Therefore, the maximum stress for each loading case was determined by this stress distribution and so, maximum stress region of road wheel could be possible to be identified, as seen Figure 2. Afterwards, maximum and minimum loads to be applied for fatigue analysis were set for the region of test specimen on road wheel. Finally, the test specimens prepared in accordance with the ASTM standards were put into both experimental fatigue test and numerical fatigue analysis.

Finite Element Model and Mesh Structure

First step is to create a 3-D solid model to start finite element analysis. Therefore, three dimensional data of the road wheel which was supplied from manufacturer was used for creating this model for the analysis. The focus was put on the location indicated in Figure 2 from the outer side of road wheel which was determined by stress analysis.

Mesh structures are generated by using ANSYS Workbench software. The stresses in all elements are combined with various functions to determine the total stress. Finite element mesh structure includes three elements which are tetrahedral, prism and pyramid. In the analysis, 217,869 nodes and 121,342 elements were comprised for the road wheel, see Figure 3. On the other hand, for the specimens for fatigue test of road wheel, mesh structure was also generated and 5973 nodes and 3486 elements were used for each test specimen.

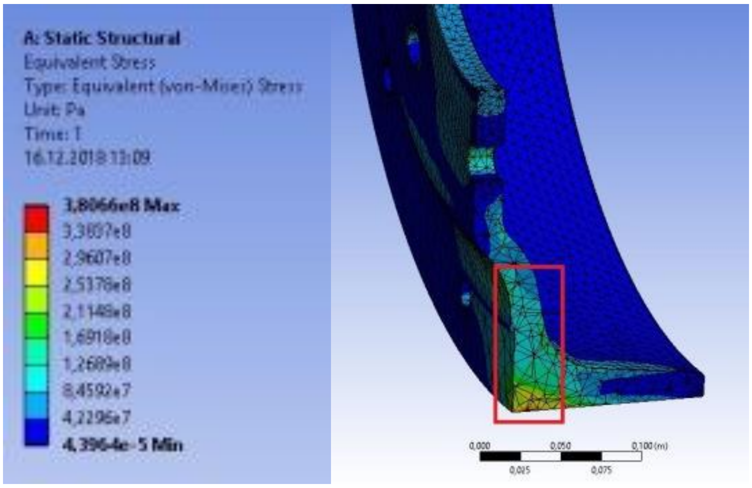


Figure 2. Maximum stress region of road wheel

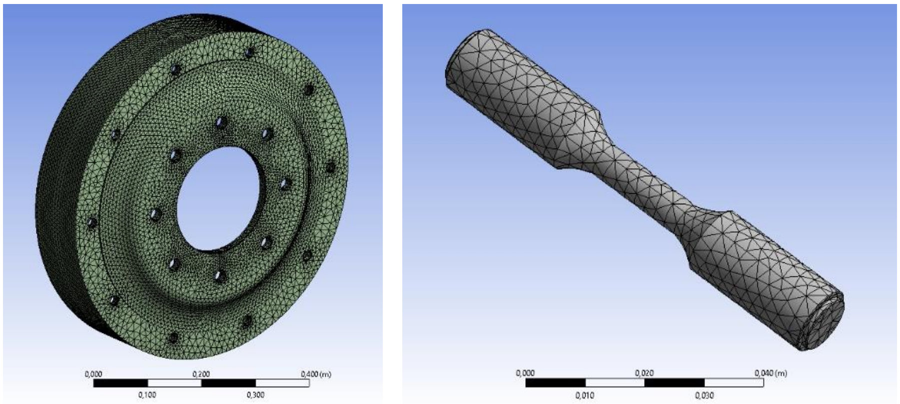


Figure 3. Mesh structure of the road wheel and test specimen

There are two contact regions which are central (axle of the road wheel) and ground surface. The loading forces are transmitted with the aid of these surfaces so there must be friction force to transmit loads to each other. Friction coefficient is determined from relationship between materials. Aluminum alloy road wheel is in contact with steel track at the ground surface and steel axle at the center of the road wheel. So, frictional coefficient between steel material (axle and track) and aluminum (road wheel) was selected as ‘0.61’ which is valid for clean and dry surface [14].

In fact, tracks are vulcanized with natural rubber. In this study, the aim of using steel for contact surface instead of rubber is to create the worst case when there is any deformation in rubber, it may contact with steel track.

Another important point of finite element model is to determine the boundary conditions. Support points, loading conditions and temperature can be given as an example for boundary conditions. There are one fixed support, one applied force and two displacements in the analysis. These are shown in Figure 4. Fixed support of road wheel is shown as ‘A’ region determined as the place where road wheel and steel track contacted each other. Radial load is shown as ‘B’ region. Displacements as support points are shown as ‘D’ and ‘C’ regions in Figure 4. While these regions enable Y coordinate to be movable, they hinder the movement of X and Z coordinates. The reason for selecting such movement restrictions in analysis is to examine the effects of radial force on the road wheel correctly.

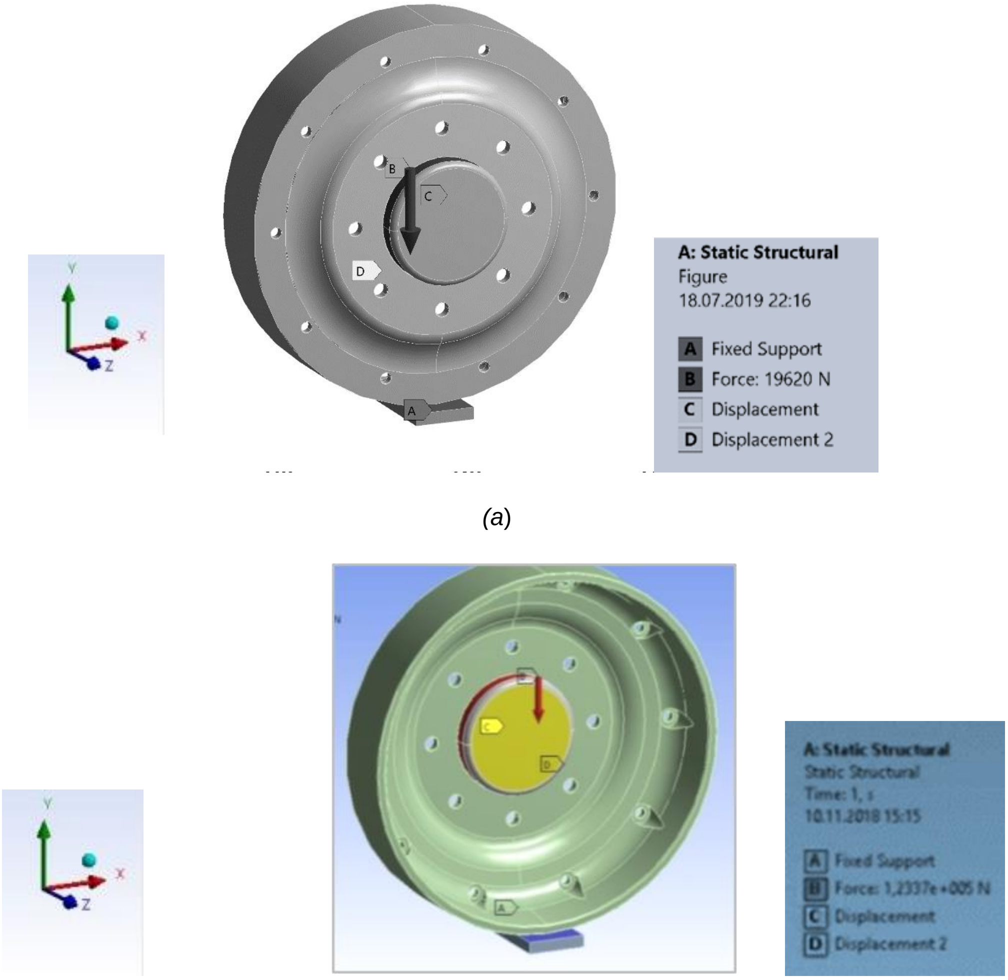
Aluminium road wheels are formed by flow forming (spin forming) method. Therefore, longitudinal un-notched forged fatigue data from literature [6] which is shown in Table.1 were selected to use in finite element analysis and to calculate the fatigue life of aluminium road wheel. Relationship between alternating stress and fatigue life values of aluminium 2014 – T6 are indicated in Table.1 [9].

Road wheels may be exposed to various loads; they are called as radial, bending and torsion. Fatigue behaviour of road wheel can be changed by all types of forces. When the tracked land platform is maneuvered to right or left direction, it can be subjected to different torsion and bending forces. In this study, only the effect of radial force, which is the most important one, is investigated to analyse fatigue behaviour of road wheel. That is why, maximum and minimum radial forces affecting the road wheel and fatigue behaviour of road wheel were determined.

Equivalent stress, total deformation, maximum principal elastic strain and fatigue life were analysed for aluminium road wheel. Since the parts are exposed to variable loads, mean stress is considered in the calculation generally. Gerber Criteria was selected to make fatigue analysis of aluminium road wheel in this study since ductility is a featured mechanical property of the aluminium. Fatigue of road wheel test specimen was carried out by constant amplitude load.

Results of Finite Element Stress Analysis on Road Wheel

The Von – Mises yield criterion is used to determine equivalent stress on the aluminium road wheel in this study. The uniaxial radial load causes different types of stresses due to the geometry of the road wheel. The load which caused the plastic deformation on the road wheel was determined as the maximum load.



(*a*)

(*b*)

Figure 4. Boundary conditions of road wheel: (a) outside (b) inside

Table 1. Axial loading fatigue test data of hand forged 2014T6 aluminium alloy at stress ratio A=∞ [12, 13]

Longitudinal Un-notched Specimen		
Specimen No	Alternating stress in ± [MPa]	Cycles to rupture
A4L – 31	165,47	19,097,200
A4L – 14	172,36	14,268,800
A4L – 15	179,26	9,277,100
A4L – 25	179,26	7,910,100
A4L – 34	186,15	2,790,700
A4L – 33	193,00	469,300
A4L – 13	193,00	565,000
A4L – 23	220,63	473,900
A4L – 22	248,21	150,600
A4L – 35	248,21	108,100
A4L – 32	268,89	58,100
A4L – 12	289,57	53,500
A4L – 24	289,57	45,500

Stress analysis was used to predict fatigue life of aluminium road wheel in this study. A static analysis on the road wheel has been performed with using maximum load (23,400 Kg) which is the load at which permanent deformation has been first observed. A road wheel statically loaded up to a value of 23,400 Kg is shown in Figure 5. All other applied loads to road wheel to determine the maximum stress value in the region of the test sample and maximum stress values on the road wheel are shown in Table.2.

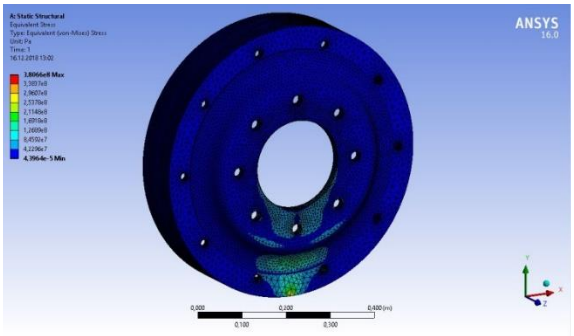


Figure 5. Equivalent stress (von-Mises) of aluminium road wheel

When stress analysis is performed at 2,000 Kg of minimum static loading applied to the road wheel, the maximum stress on the lower surface of road wheel is 56 MPa and by considering cross-sectional area, maximum stress on the test sample region is found to be 12 MPa. When 23,400 Kg of maximum static loading is applied to road wheel, maximum stress on the lower surface is going to be 380 MPa read from stress distribution and therefore maximum stress on the test sample region reaches 126 MPa. This value (380 MPa) corresponds to the point that the road wheel goes to permanent deformation. Since the test specimens could not be cut and machined from the lower surface of the road wheel where the maximum stress has occurred, it was gathered from the thickest of the road wheel which is the radially loading affected area.

When calculating the alternating stress to be used in fatigue analysis and test, it was clearly seen that the maximum stress developed on the test specimen region of road wheel has occurred very small comparatively. Assuming that the road wheel could be worked under much harder loading conditions so alternating stress has to be reconsidered based on these conditions. Therefore, maximum stress of alternating stresses should be determined according to 380 MPa of the yield strength of aluminium used. From this point of view, the maximum stress value to be used in fatigue analysis should be selected as close as possible to 380 MPa which is the starting point of the permanent deformation of road wheel. So, it was decided to use 324 MPa as maximum stress value for fatigue analysis. On the other hand, minimum stress was selected as slightly over of the static load (2,000 Kg) that the road wheel would experience at the region that test specimen taken. Even tough minimum stress (56 MPa) has been reached at that region, the minimum stress to calculate alternating stress was conservatively preferred as 80 MPa. As a result, maximum stress and minimum stress was determined as 324 MPa and 80 MPa respectively for determination of alternating stress range of test specimen cut from road wheel.

When the stress distribution is examined, the stress range inside of the road wheel is seen in between 84 MPa and 126 MPa. Therefore, it was decided to take the test samples from the part of the road wheel indicated by a rectangular frame in Figure 2 since the highest radial stress value was also in this section.

Results of Finite Element Fatigue Analysis of Test Specimen

Considering 80 MPa and 324 MPa radial stresses and test coupon’s dimensions according to ASTM E466/E606 standards, the maximum and minimum compression load to be applied for fatigue test samples needed to be recalculated. Consequently, the minimum compressive force was calculated for the 80 MPa and it was found as 210 Kg. and maximum compressive force was calculated for 324 MPa and determined as 850 Kg. The alternating stress which was applied at the fatigue test of test specimen was therefore calculated as 122 MPa.

When fatigue of test specimen was analysed between compression stresses of 80 MPa and 324 MPa, it was understood from the data given in Table 1 that almost infinite fatigue life between these loads exists since alternating stress of 122 MPa is well below 165,47 MPa which is corresponding to roughly 19 million cycles to rupture. No fatigue crack has been observed in the middle part of the test specimens on which 122 MPa alternating stress was applied.

EXPERIMENTAL

This experimentation includes experimental test setup, material specifications, fatigue testing and non-destructive test results of the specimens. In the present study, stress and fatigue analysis of aluminium alloy road wheel were carried out by using finite element analysis (FEA) method. Then, FEA results obtained were verified by using experimental results. Non-destructive methods were utilized to observe the difference between fatigued and non-fatigued parts.

Table 2. Calculated stress values by FEA for aluminium road wheel

Loadings [Kg]	Maximum stress values in the region of the test sample [MPa]	Maximum stress values on the road wheel [MPa]
2,000	12	56
4,000	31	95
6,000	45	135
8,000	58	175
10,000	70	211
12,000	81	245
14,000	91	275
16,000	100	302
18,000	108	325
20,000	115	346
22,000	122	366
23,400	126	380

Test Specimens and Test Setup

Test specimens of aluminium road wheel and test setup are explained in this section. First of all, the test specimens were cut from the outer side of road wheel and this location is indicated in Figure 6. The test specimens were manufactured according to ASTM E606 standards recommended for low-cycle fatigue specimens and also gripping adapters made by steel were manufactured to assemble the test specimens to fatigue test machine. The test specimens subjected to uniaxial forces were used to determine fatigue properties of nominally homogeneous aluminium materials.

Fatigue test was applied to three test specimens between 80 MPa and 324 MPa compression stresses under 10 Hz frequency with MTS Servo hydraulic test system (100 kN).

Testing

The specimens were connected to the hydraulic gripper of the test machine with the aid of steel adapters. The connection of test specimen with steel adapters is shown in Figure 7. Compression fatigue loading was applied to 3 number of test specimens. Since the maximum speed of a conventional tracked vehicle is known roughly 65 Km/h, the revolution of the road wheel is calculated at this rate of speed as 9 rev/sec. Therefore, frequency of fatigue test was selected roughly 10 Hz. Experimental fatigue test was limited to the number of cycles of 1,500,000. Limitation of cycles at fatigue test was due to time and cost factors. 122 MPa of alternating stress applied on the test specimen was calculated by the compression stresses between 80 MPa and 324 MPa.

Over the course of fatigue test, no damage was observed on the images taken from the samples every 250,000 cycles with the Nikon Shuttle Pix digital microscope. Totally, 6 images were taken per sample and cracks that may occur on the surface were not observed.

Non-destructive Test Methods of Specimens

Radiographic testing (RT**):** In radiographic testing operations, firstly, two different radiographic tests were applied to test specimens so there are two images obtained. Type of operation-1 was low duration. Type of operation-2 was more than 15 seconds from operation-1 and the parts were shot by rotating 90 degrees. ‘Y’ points out the ones that were exposed to fatigued test specimens, marked as Y1, Y2 and Y3. ‘S’ points out the ones that were exposed to non-fatigued parts, marked as S1, S2 and S3. The numbers below the parts are compatible with the fatigue test. Operation-1 is shown in Figure 8.

Liquid penetrant testing (PT): The test specimens which were exposed to fatigue loading were also examined by liquid penetrant testing. They are marked as Y1, Y2 and Y3 which are shown in Figure 9. Since no fatigue symptoms or cracks were observed in the fatigued parts, Non-fatigued test specimens were not examined by liquid penetrant testing.

Scanning electron microscope (SEM): There are several images taken for both separately fatigued test and non-fatigued test specimens in SEM analysis, see Figure 10 and Figure 11. In order to examine the surface of each fatigued test specimens, specimens were cut from mid-section and polished. When images that were taken from scanning electron microscope (SEM) were examined, it was found that no change in the grain size and not any discontinuity on fatigued and non-fatigued parts.

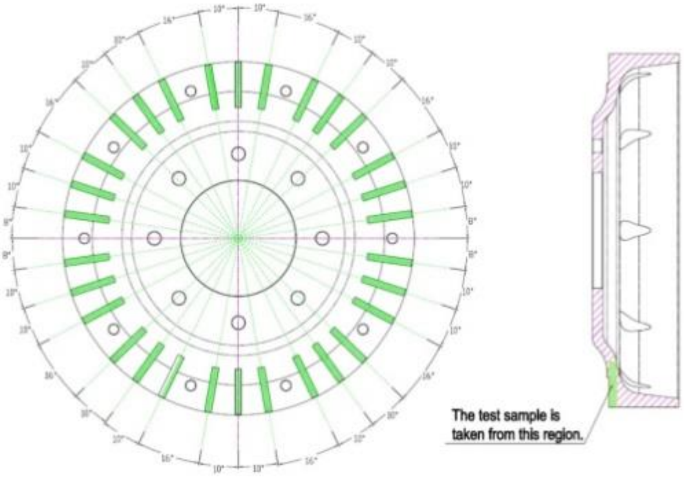


Figure 6. Representation of the test sample region on road wheel

Figure 7. Fatigue testing of road wheel test specimens

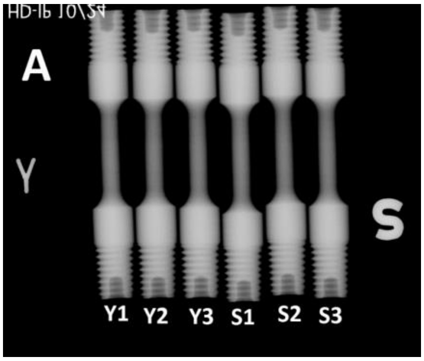


Figure 8. Radiographic test of road wheel fatigue test specimens

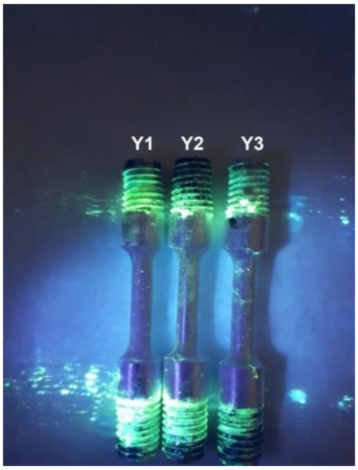


Figure 9. Liquid penetrant inspection of road wheel fatigued test specimens

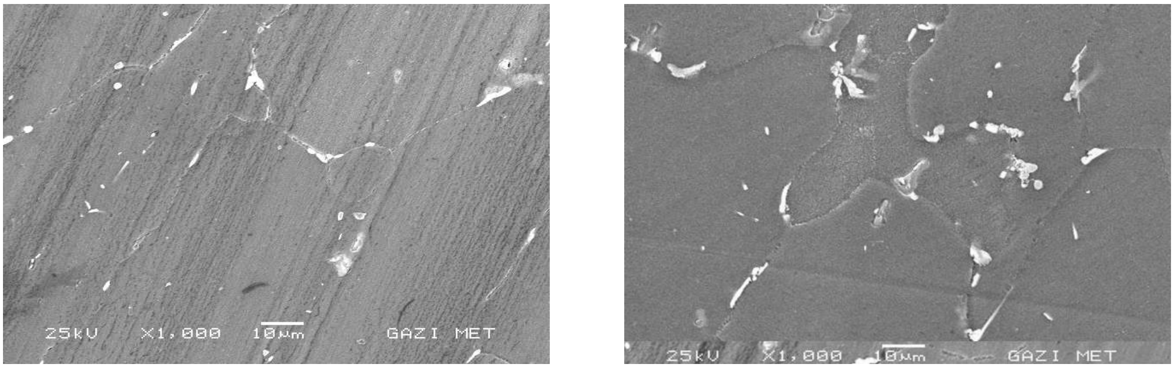
Optical microscope: There are several images taken for both separately fatigued test and non-fatigued test in optical microscope analysis, see Figure 12 and Figure 13.

The surfaces were analysed by optical microscope and it was found that no change in the grain size and not any discontinuity on fatigued and non-fatigued parts.

RESULTS AND DISCUSSION

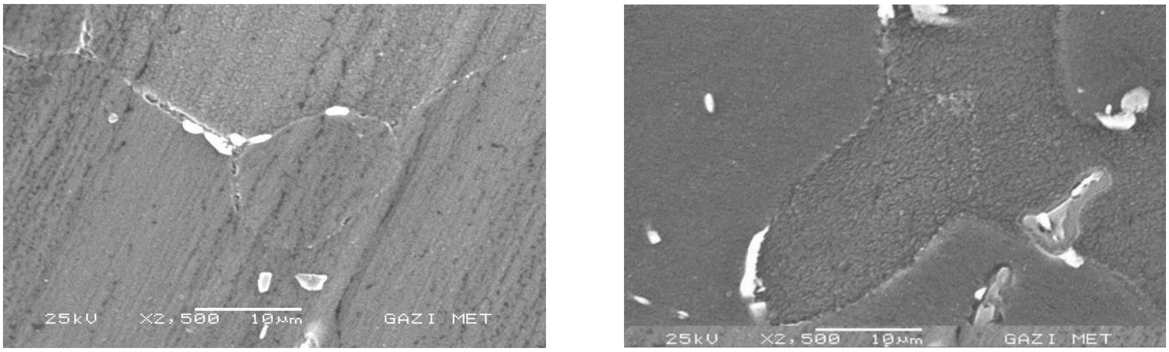
Results Obtained From Fatigue Prediction and Experimental Analysis

First of all, stress analysis of the road wheel has been executed to determine the maximum stress due to static weight of 2,000 Kg experienced per wheel of the vehicle which totally weighs of 47 tones and maximum equivalent stress (von-Mises) just before showing permanent deformation under loading on aluminium road wheel. It was found that maximum compression stress due to static dead weight is going to be 56 MPa and on the other hand maximum compression stress that the wheel is able to carry without permanent deformation is going to be 380 MPa under 23,400 Kg static loading. This maximum compression stress also corresponds to the yield strength of Al 2014 – T6 which is 380 MPa.



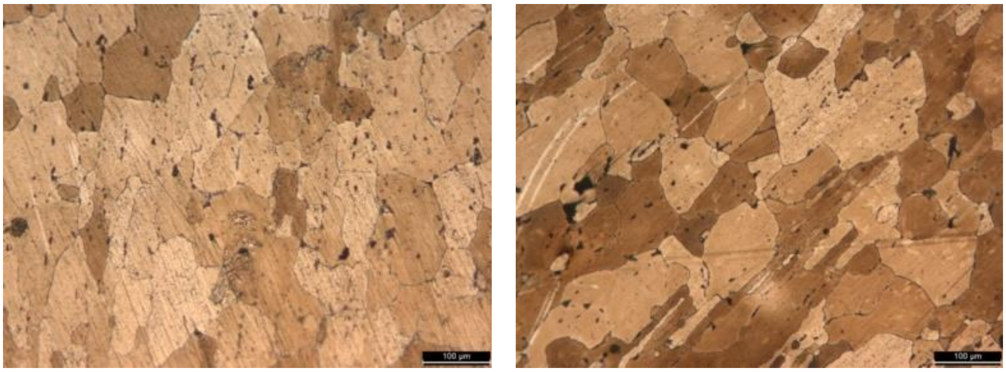
(a) (b)

Figure 10. SEM analysis of (a) fatigued & (b) non-fatigued test specimen in 1000x



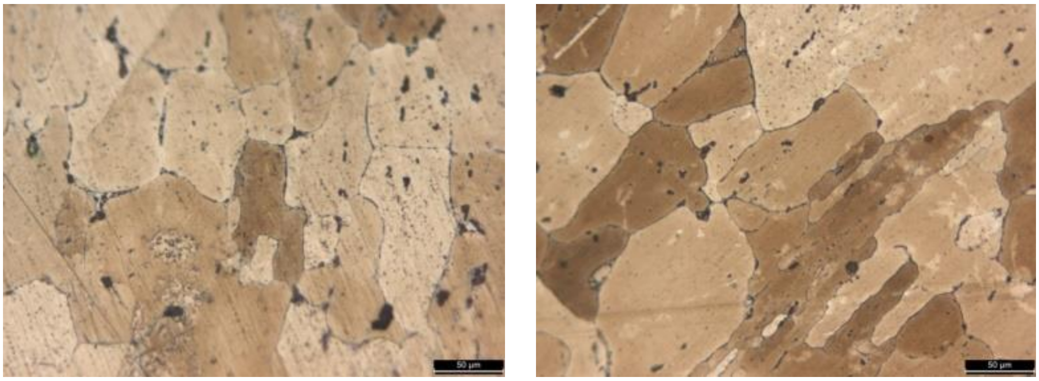
(a) (b)

Figure 11. SEM analysis of (a) fatigued & (b) non-fatigued test specimens in 2500x



(a) (b)

Figure 12. Optical microscope analysis of (a) fatigued and (b) non-fatigued test specimen in 100x



(a) (b)

Figure 13. Optical microscope analysis of (a) fatigued and (b) non-fatigued test specimen in 200x

Assuming that the road wheel could be practiced under tougher loading conditions, alternating stress has been recalculated based on these tougher conditions. Therefore, maximum stress was selected 324 MPa as near as possible to 380 MPa which is the point that the beginning of permanent deformation value of road wheel and minimum stress value was selected as 80 MPa being over the static dead weight load of 56 MPa for per road wheel. Therefore, the purpose of selecting maximum stress of 324 MPa (18,000 Kg) is to consider harsh environments such as potholes and rocky terrains that aluminium road wheels might be exposed to during the movement of the vehicle.

These stress values will correspond to 210 Kg load for 80 MPa and 850 kg for 324 MPa when considering cross sectional area of test specimen. Therefore, based on this stress values decided, test specimens taken from road wheel was put into the fatigue test numerically with maximum 324 MPa and minimum 80 MPa stress range and based on the data given in Table 1, it could be said that high cycle fatigue life between these loads exists over 19 million cycles to rupture. No fatigue crack is observed in the middle section of test specimens. On the other hand, test specimens was experimentally fatigue tested in parallel to the numerical prediction between compression stress of 80 MPa and 324 MPa and it was found that none of fatigue damage has been observed on the middle part of test specimen up to 1,500,000 cycles as well.

Discussion and Comments

As a matter of fact, the whole aluminium road wheel could have been fatigue tested as a whole by a special test machine. However, since the manufacturing of this kind of specially designed testing device will be costly in terms of time and money, this method was not preferred at this study.

Normally, the rubber part on outer surface of road wheel is changed in every 10,000 km and rubber part's damping effect was not considered in the finite element analysis. By a simple calculation, the outer radius of road wheel is 628 mm and circumference of the wheel is calculated as 1972 mm. When the road wheel moves forward 2,958 km, each point on the outer ring of the wheel might experience the loads between 2,000 Kg - 18,000 Kg approximately 1,500,000 times.

When the test specimen was tested up to 1,500,000 cycles in testing machine it was found no crack initiation occurred due to cyclic loading, it means that one aluminium road wheel manufactured by flow forming could safely travel at least 2,958 km without any damage and crack. Considering the damping capacity of the rubber pad on the outer ring of the road wheel, this service life can be estimated more than 5,000 km. In other words, the service life of the road wheel is well beyond from 3,000 km. The reason of the limitation of cycles at 1,500,000 during the experiment is just due to savings from time and cost since rubber pad service life is roughly 3000-5000 km.

As clearly known, aluminium is one of the most common elements in the world. When the price and weight of aluminium and steel are compared with each other, aluminium is always lighter but considerably expensive than steel. For this reason, replacing the steel road wheels used in military platforms with the aluminium ones manufactured by flow forming contrary to forging or casting would be more reasonable and beneficial when existing steel one's service life is ended. The densities of aluminium and steel material are 2,7 g/cm^3 and 7,85 g/cm^3 respectively. When the weight of one aluminium and steel road wheel is calculated, aluminium road wheel is weighed 27 Kg and steel road wheel 79 Kg respectively. There are 24 road wheels in the platform. When all of the road wheels are considered, total weight of aluminium alloy road wheel would be 648 Kg while total weight of steel road wheel is already 1896 Kg. When aluminium road wheels are used in the platform, the total weight of the vehicle would be roughly 1,200 Kg lighter.
The aluminium road wheel was only analysed and tested for radial loads. When combined loading is performed on the aluminium road wheel, exact results will be determined. It is only determined that the road wheel is durable in terms of plastic deformation when compression loads are applied in radial direction. A different loading condition such as bending can be analysed and tested for the aluminium road wheel in the future work.

CONCLUSION

Road wheels are the important parts of tracked army platforms and their durability and service life affects survivability of army platforms. The objective of this study was to predict the fatigue behaviour and stress distribution of 2014 – T6 aluminium road wheel of a heavy tracked platform and to see whether the way of manufacturing method of aluminium road wheel would affect fatigue life.

When analysis and test results are considered, it was seen that aluminium road wheel of the platform which was manufactured by flow forming method is durable enough for overloading harshly conditions. In fatigue test, 1,500,000 cycles, verified by numerical analysis, correspond to approximately 3,000 Km running of road wheel. Even though the road wheel had run under these conditions, the aluminium road wheel would definitely survive at least 3,000 Km without any deformation or fatigue crack failure. Since the rubber material around the road wheel will not transfer the higher loads to road wheel due to its damping capability and otherwise, since the aluminium road wheel is subjected to compression - compression loads, crack formation or crack growths would be more difficult. Thus, it could be predicted that the aluminium road wheel would be more durable over its calculated lifetime.

All in all, the use of aluminium road wheel instead of steel road wheel provides weight reduction on tracked land platforms so that aluminium road wheels increase the mobility of the platform or may provide more payload carrying capability. Therefore, aluminium made road wheels might be a good candidate for replacing the existing road wheels manufactured by steel material if they are able to be manufactured by flow forming method due to cost effectiveness. This provides an important advantage over the battlefield.

KARA ARAÇLARINDA ALÜMİNYUM 2014-T6 MALZEME KULLANILARAK SIVAMA YÖNTEMİ İLE YAPILMIŞ PORTÖR TEKERİNİN GERİLME VE YORULMA ANALİZLERİNİN YAPILMASI

Savunma platformlarında kullanılan portör tekerleri getirdiği ağırlığa rağmen geleneksel olarak çelikten kolay ve ucuz bir biçimde üretilmektedir. Portör tekerlekleri için alternatif malzeme daha hafif olan alüminyum alaşımı olup, genel olarak döküm veya dövme üretim yöntemleri kullanılmaktadır. Ancak, bu yöntemlerin dayanıklılık ve üretim maliyeti nedeniyle bir takım zafiyetleri mevcuttur. Bu nedenle, bu çalışmada portör tekerlerinin levha halindeki alüminyum (2014-T6) kullanılarak sıvama yöntemi ile üretildiği takdirde mukavemet ve düşük-döngülü yorulma açısından diğer malzemeler ve üretim yöntemlerine oranla daha iyi bir alternatif olabileceği sayısal ve deneysel olarak ortaya konmaktadır.

Anahtar Kelimeler: Sıvama yöntemi, portör tekeri, paletli platformlar, sonlu elemanlar yöntemi, gerilme analizi, yorulma analizi

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