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A Review On Fatigue And Creep Behaviour Of Aluminium Composites

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ABSTRACT
A composite material is a material framework made out of a reasonably organized blend or mix of at least two nano, small scale, or large scale constituents with an interface isolating them that vary in synthetic synthesis, shape, which are basically insoluble in one another. Diverse kinds of composite materials are accessible and these are expanding a direct result of their great improved properties, among these Metal Matrix Composites discovers its applications in different viewpoints like aviation, car, barrier, and marine and so on. In these MMCs, aluminum-based metal grid composites are by and by broadly being used in vehicle area, aviation and brandishing types of gear because of their high quality and firmness with diminished weight. There are a few creation procedures are accessible to process these composites. The readied composites are generally assessed for improved properties. To assess these composites, one can lead the investigations like hardness, pliable, pressure, fatigue, creep and tribological tests according to ASTM guidelines. In the present survey paper an endeavor has been made to examine diverse MMC preparing techniques and properties assessment.
Key words: Composites, Metal Matrix Composites, Processing, Properties, Fatigue, creep

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I. INTRODUCTION

Composite as system is defined as "Multi-component material comprising of multiple different phase domains in which at least one type phase is continuous". It commonly composed of the matrix and reinforcement, where matrix is the base metal and reinforcement is alloying element. Matrix and reinforcement are insoluble in composites [1, 2].

Conventional monolithic materials such as metals and their alloys, ceramic's or polymeric materials cannot meet some specific properties such as, good combination of strength, stiffness, toughness and density which are required in the many of the modern technology application.
To our come this disadvantage, a new of class of material revolution started in 20^{th} century today we called them as composites.

Composites exhibits a very good range of mechanical and microscopic properties such as low density, high tensile strength, good high cycle fatigue response, creep and wear, enhanced stiffness, high operating temperature, low coefficient of thermal expansion high toughness, corrosion resistance and high specific modulus etc., because of its high strength to weight ratio which help in fuel consumption reduction in aircraft and it badly required in the air-crafts industries [3].

In industries Electrical mouldings, Decorative laminates, High performance Cookware, Sealants and gaskets, Heat shield systems, Components for high-temperature gas turbines, for example, ignition chambers, stator vanes and turbine blades, Brake plates, Brake disks and stopping mechanism segments utilized in outrageous warm stun conditions, Components for slide bearing under Extreme loads requiring high corrosion and wear obstruction, Carbide drills are produced using an extreme cobalt lattice with hard tungsten carbide particles inside, Components for burners, flame holders, and hot gas ducts [4].
Other application of composites includes Aircrafts skins, bearing, electronic packaging, engine cylinder lines, pistons, space structure tubing in nuclear plants [5, 6] etc.,

A variety of different matrix available such as Aluminium alloy, titanium, and magnesium etc., most commonly used matrix material is aluminium because of its excellent properties. A verity of reinforcement is available such as Gr, TiB, TiC, TiO_2, Al_2O_3, Fly ash, SiC, Hematite, and ZrO_2 [7] etc.,

They are different technique are used to manufacture composite's such as
1. Solid state method
2. Liquid state method
3. Semi solid-state method
4. Vapour deposition
5. In-situ fabrication technique

Main disadvantage of composites is Fatigue and creep life is very low but in aircraft industries main failure load is thermal fatigue which can leads to a severe damage. However, a lot research has been done in this area. Composites life is affected even by the reinforcement particle size and type of manufacturing process adopted.

Thermal fatigue failure of the Composites is most dangerous. Thermal fatigue is caused by periodic or cyclic temperature changes and constraints internal or external which is produce stress concentration this leads to the crack propagation in the materials. The internal constrain are the stress gradient produce due to temperature difference in the matrix and reinforcement interphase which leads to crack formation at interference.

The presence of the reinforcement in the composites are confirmed by the studying the Microstructure of the composites by XRD, EDS Methods [8].

In our work we have re-viewed a research's done on composites fatigue and creep failures, there result comparison and evaluation with experimental and theoretical procedure.

A very less work has been done in the thermal fatigue and creep failure of the aluminium alloy composites.

1. Classification of composites:

Composites are basically classified into three groups and this classification is based on the matrix materials.
1. Polymer matrix composites
2. Metal matrix composites
3. Ceramic matrix composites

Polymer Matrix Composites (PMCs): Polymer Matrix Composites (PMCs): Polymer Matrix Composites are also called FRP - Fiber Reinforced Polymers (or Plastics). These materials utilize a polymer-based resin as the matrix, and an assortment of filaments, for example, glass, carbon and aramid as the reinforcement.

Metal Matrix Composites (MMCs): Metal Matrix Composites progressively discovered its applications in the aviation and automotive industry. These materials utilize a metal, for example, Aluminium as the matrix, and fortify it with strands, particulates or bristles, for example, silicon carbide. Fired Matrix Composites (CMCs): Ceramic Matrix Composites are utilized in high temperature condition.

Ceramic Matrix Composites (CMCs): Ceramic Matrix Composites are used in very high temperature environment. These materials use ceramic as the matrix and reinforce it with short fibers, or whiskers such as those made of silicon carbide and boron nitride.

The MMC's remain the choice because of its application from packaging to the aerospace industries due to their mechanical properties. This material has some excellent characteristics over the conventional materials. Aluminium alloy remains the dominating in the aircraft because of which 80% of the aircraft structure made of it.

AMMC's (Aluminium metal matrix composites)

Aluminum has been used as a matrix material due to its light weight, high strength, excellent wear resistance properties, high temperature, easy to prepare the composite and availability in abundance. Aluminum alloys such as Aluminum-silicon, Aluminum-magnesium-silicon, Aluminum-zinc-magnesium, Aluminum-copper, and Aluminum-copper-magnesium have been tried as matrices in the processing of AMMCs [9]. These are classified into the series and each series dominating an alloying element like,

Series designation	Composition
1000 Series	At least 99% pure Aluminum.
2000 Series	Al-Cu, Al-Cu-Mg Copper alloys with high strength; and reduced stress and corrosion resistance.
3000 Series	Al-Mn, Al-Mn-Mg alloys, Manganese alloys with moderate strength and ductility.
4000 Series	Silicon alloys with lower melting point and better cast ability.
5000 Series	Al-Mg alloys magnesium and silicon alloys having medium and excellent wettability.
6000 Series	Al-Mg-Si Magnesium and silicon alloys having medium strength with heat treatment, better wettability and cast ability.
7000 Series	Al-Zn-Mg, Al-Zn-Cu-Mg. Zinc alloys with high strength.
8000 Series	Al-Li-Cu-Mg, Lithium alloys having low density and high strength.
9000 Series	Used in manufacturing practice

The creep behavior of the aluminum-based composites manufactured from the powder metallurgy and solid solution based is different because of the threshold stress interduce by the interaction between moving dislocation and dispersion particles. The dispersion particles are nothing but oxides formed during the solidification.

Al-SiC (Silicon Carbide reinforced with the aluminum matrix) are most preferred series in structural and thermal application. SiC are the ceramics particulates having very high thermal stability and hardness. The creep strength of discontinuous Al-SiC can be increased by increasing the creep strength of composites matrix by dispersion strengthening of the matrix a stable particle for example alumina particles [10].

To determine the location of crack in the specimens a technique called NEWMS (Non-linear elastic wave modulation spectroscopy) and determines the acoustic energy at a point TRA (Time reversal Acoustic).

Literature Review:

A study is carried on a study for fatigue and creep behaviour of the composites. The result was observed as follow

"**Thermal fatigue behaviour of SiC/Al composites synthesized by metal infiltration**" by C.M Lawrence Wu and G.W. Han [11]. They taken Al as matrix and SiC particulates of 10µm 65 vol% and 35µm 35 vol% of the reinforcement. the perform was first prepared by pressing the SiC and partial sintering. This is then followed by pressure less spontaneous infiltration of molten Al-10Si-3Mg alloy into the SiC preform at 850°C in nitrogen atmosphere. The results show that crack is generated at the tip of the specimen and the crack length will developed after each thermal cycle. The propagation of the thermal fatigue crack occurred by fracturing large particulates in the composites. the crack passed through the large particulates instead of the around the matrix this emphasized that adhesion of particles and the matrix is excellent such that failure interface between particles and matrix is doesn't exist. It tends to be reasoned that by diminishing the measure of the reinforcing particles, they will be more improbable broke, as the crack way will be more probable through the framework. As the matrix material has higher fatigue resistances than the fortifying particles. The general fatigue resistances will be enhanced and the thermal fatigue life of the composite with lesser volume division of reinforcement is better then higher volume part of support.

"**Study of fatigue behaviour of 7475 aluminium alloy**" by B.B Verma et al., [12] In their work they have used a new series of composite to our come the disadvantage of an important aircraft structural material 2024 Aluminium alloy, such as low yield stress level and relatively low fracture toughness which limits the application of this alloy in highly stressed region. The medium strength alloy such as 7075, 7050 (Al-Zn-Mg) are modified in their chemical composition to our come the fatigue crack growth in aqueous saline environments. This leads to the development of 7475 (Al-Zn-Mg-Cu) alloy this is modified version of 7075 alloy by reducing the iron and silicon and altering quenching and aging condition. The 7475 are accessible in T61 and T761 tempers, though the plates are for the most part tempered to T651, T7351 and T7651 conditions. These plates have the strength very close to some tempered 7075 alloy and whereas the fracture toughness values are up to 40% greater than that 7075 alloys. The objective of this investigation is to characterize S-N curve and crack growth behaviour of 7475 aluminium alloy in T7351 temper condition. The fatigue life test is performed using 100kN servo hydraulic testing machine under load control condition at a frequency of 3Hz were used for all tests. Comparison has made between 2024-T351, 7050-T73651, 7075-T651 and 7475-T7351. 7475-T7351 has high crack sturdiness in Both LT and TL orientations yet has insignificantly second rate yield quality however marginally prevalent flexibility. In S-N Curve it is seen that at stress level of the 250Mpa (R = - 1) the quantity of cycle to failure is $1.86 \times 10^{+5}$and at the stress level of 195Mpa the quantity of cycle to failure is expanded to$2.47 \times 10^{+6}$. The 2024-T3 and 7475-T7351 alloys perform better than 7075-T6 alloy over the entire investigated stress range, at low stress range 7475-T7351 has more life cycle but the number life cycles are very low at high stress region hence it shows that 7475 alloy has a good application in low fatigue stress region. The study of fractographic show that crack initiation in this alloy took place from surface grain, typical in high purity metals and alloys and the mechanism of stage 2 crack extension changed from cyclic-cleavage at low ΔK to ductile striation at relatively high ΔK.

"Low Cycle Fatigue Properties of 2124/SiC Al-Alloy Composites" by Ilyas Uygur et al [13] the objective of this study is to discuss the strain-controlled fatigue response of 2124 Precipitative hardened Al-alloy reinforced with SiC particulate. The effect of volume fraction (V_f) particle size (P_s) of reinforcement and strain ratio (R) are examined under strain control conditions in various strain ranges. Direct comparisons between monotonic and cyclic stress strain responses are also considered. Fatigue samples are examined using scanning electron microscopy in order to understand the failure mechanism (SEM). The tested material was commercial 2124 (Al-Cu-Mg-Mn) Al-alloy with 17vol% and 25vol% with SiC particles. All of the materials which were referred as AMC217 (17vol% 2-3 µm SiC_p), LAMC217 (17vol% 10-20µm SiC_p), AMC225 (25vol% 2-3µm SiC_p) and LAMC225 (25vol% 10-20µm SiC_p) were produced by Aerospace Composite Materials (UK) using powder metallurgy (PM) processing. The low cycle fatigue life test has shown that an increase in (V_f) and (P_s) will reduce the tensile ductility of composites, and also reduces the LCF properties. A primary factor contributing to these lower life times was related to the concentration of plastic strains. Comparison of monotonic tensile stress-strain response and cyclic maximum stress-strain response of AMC225 composites showed established behaviour at R=0 strain ratio. Similarly, at high levels at fully reversed (R = -1) strain ratio. The morphology study shows that essentially matrix dominated, fracture surface of composites revealed an overall brittle appearance on a microscopic scale. General fracture behaviour which was ductile mode carried by the void nucleation.

"Low-cycle fatigue behaviour of particulate SiC/2024Al composites at ambient and elevated temperature" by N.L. Han et al [14]. The present study is to investigate the difference in cyclic deformation behaviour and plastic-strain fatigue lives of a SiC particles-reinforced 2024Al alloy and its unreinforced counterpart at ambient and elevated temperature. The 15vol% SiC_p/2024Al composite used in the present investigation was fabricated by casting. The ingots are extruded at 420°C at extrusion ratio of 20:1. The composites and unreinforced materials were heat treated for T-6 condition, at 498°C kept for 1Hr, quenched in cold water and artificially heated to 190°C the aging last for 7Hr and 10Hr for composites and unreinforced material respectively. Tensile properties of the composites and matrix material are followed as, in comparison with the matrix Al-alloy ceramic reinforcement showed increase in the stiffness and yield strength at expenses of tensile ductility. The reinforcement showed the dropped in modulus and strength at higher temperature. The specimen subjected to the higher plastic-strain amplitudes showed more cyclic hardening and a faster hardening rate. At 190°C composites showed the cyclic hardening at early stage and there was rather long stable intermediate region at middle strain amplitudes then it goes to cyclic softening and cyclic softening will become more dominant at higher high plastic strain amplitudes. The cyclic deformation behaviour of the 2024Al-T6 alloy was cyclic hardening at room temperature. The 2024Al depends on the plastic strain amplitude for the for the onset of cyclic hardening. The 2024Al alloy shows cyclic softening at elevated temperature, which is similar in character to composites. The cyclic response stress of the matrix alloy dropped at elevated temperature in comparing to the behaviour at room temperature. For the plastic-strain fatigue life most striking feature is life of composite is longer at elevated temperature than at room temperature. The gap in fatigue life was almost constant entire range. The graph obtained by drawing plastic strain vs loading reversals to failure was straight line which obtains by linear regression analysis and fits the Coffin-Manson relationship:

$$\frac{1}{2}\Delta\varepsilon_p = \varepsilon_f^1(2N)^C$$

Aa the plastic strain amplitude reduced the difference between the composites and the Al alloy was reduced moreover the composites had a tendency to exceed the Al alloy in fatigue endurance in the case of very low strain loading. The fractography of the specimen shown that fatigue striations were seen on the fracture surface of the unreinforced matrix at room and elevated temperature. in case of composites un-equiaxed dimples there were broken or de-cohesion SiC particles.

"Experimental study on fatigue crack identification of 7075 aluminium alloy plate using combination NEWMS and TRA" by G L Gao et al [15] the aim of the paper is to contemplate the sign and recognizable proof of the fatigue crack in 7075 aluminum compound examples in light of the mix NEWMS and TR techniques. In experiment two plates one intact another with the crack. Two thin PZT transducer with 10mm diameter and 1mm thickness are used as the excitation sources are operated by the waveform generator FLUK294. One high frequency another low frequency 270kHz and 70kHz as central frequency respectively. The vibration velocity of the surface is measured by the laser vibrometer V1002 acted as receiver and acquired signal is stored in digital oscilloscope DPO4054 connected to the laser vibrometer and finally to computer by GPIB Interface to the digital oscilloscope and the data is processed by MATLAB. The result is as follow

The intact specimen shows the only linear frequency but cracked specimen shows the linear and non-linear frequency. The non-linear frequency is produced because of the opening and closing of the crack during loading which is also known as harmonic and sideband frequency. In order to locate the crack position, the received signals are filtered and reversed. The intermodulation signals are show the sum and difference and there are high at the crack position. The intermodulation frequency $f_{-\pm} = f_1 \pm f_2$ can be used to indicate the position of crack.

"Creep behaviour of aluminium strengthened by fine aluminium carbide particles and reinforced by silicon carbide particulates DS Al-SiC/Al_4C_3 composites" by S.J Zhu et al [16] a comparison of the creep strength for the dispersion strengthen AlC and SiC/AlC (where C in both material represent the volume fraction of $\mathbf{Al_4C_3}$). To increase the creep strength of discontinues Al-SiC, it is necessary to increase the creep strength of the matrix. The applied stress and temperature dependence of the minimum creep strain rate could be described by the phenomenological equation $\frac{\varepsilon_m kT}{D_L G_1 b} = A\left(\frac{\sigma-\sigma_{TH}}{G}\right)^n$, where D_L is the co-efficient of lattice diffusion in the composite matrix, A is a dimensionless constant, k is the boltzman constant, T the temperature, and b the length of the Burgers vector. The normalised minimum creep strain rate $\ddot{\varepsilon}_m b^2 / D_L$ was actually the same at any biased 'effective' stress $\left(\frac{\sigma-\sigma_{TH}}{G}\right)$, in a nutshell it was found that the load transfer effect does not play any significant role in the creep behaviour of ODS Al-30SiCp composite with strong dispersion strengthened matrix. The size of "structure units" is close to 1µm. the term structure means grain or sub-grain. Orlova et al, consider it as structure but the S.G Zhu et al, consider it as grain. The mean grain size used in SiC/AlC1, SiC/AlC2, SiC/AlC3 was 2.6µm in diameter and 11.4µm inter particulate distance and DS AlC1, DS AlC2 alloys was measured, it was (1.33±.40) -(1.24±.02) µm, respectively. The creep test is performed on SiC/AlC composites of 4mm diameter and 20mm length at 623K-723K. for the DS AlC1 alloy 5mm diameter and 50mm specimen. The creep data for DS AlC1 and DS AlC2 alloys as well as for SiC/AlC1, SiC/AlC2 and SiCAlC3 composites were obtained for two temperature only, namely 623K-723K. the apparent stress exponent m_c, defined as $m_c = (\partial \ln \dot{\varepsilon}_m / \partial \ln \sigma)_T$ is higher for 723K then 623K for both materials shows that true threshold creep behaviour. An essential consequence of the present work comprises in the perception that in the SiC/AlC composites the genuine threshold stress$\sigma_{TH}$is roughly relative to the shear modulus G. A comparative perception has not yet been accounted for any discontinuous aluminum or aluminum alloy matrix composites. The consequence of the structure examination in both DS AlC combination and SiC/AlC composites accessible right now don't enable the present authors to offer any stable clarification of the distinction in creep conduct of these alloys and composites. The investigation by Sherby et al. the value of true stress exponent of minimum creep strain rate, n, equal to 8 should be preferred to that equal to 5 for both DS AlC alloy and SiC/AlC composites. For discontinuous Al-SiC composites such an interpretation was presented by number of authors [26,38-40]. On the other hand, some other authors during studying creep behaviour in Al-SiCp, 6061 Al-SiCp[32,33] and 2124 Al-SiCp [27,36] and other composites found the best fit for the $\left(\varepsilon_m^{1/n}, \sigma\right)$ data point for n=5. However, the fit of $\left(\varepsilon_m^{1/n}, \sigma\right)$, still better than for n=8 is eventually obtained by n=11. Hence both the DS AlC compounds and SiC/AlC composites appear to appear as it were irregular creep behavior together with a missing proof on the structure invariant model of creep does not make it feasible for the present creators to acknowledge this model to translate the present outcomes regarding it.

"Effect of Nano-Scale Particles on the Creep Behaviour of 2014 Al" by Zhigang Lin et al [17] the aim of investigation is to find the creep behaviour for two grades of 2014-Al were prepared by powder metallurgy (PM), they have different level of oxygen (.3 and 1.0wt% oxygen). In creep investigation it has found that PM Al alloys, unlike conventional solid solution alloys of same composition exhibits apparent stress exponents and apparent activation energies that are high and variable, this variant attributed to the existence of a threshold stress in creep. It has been suggested that threshold stress origin due to interaction between moving dislocation and dispersion particles. The dispersions are nothing but oxides which form due to processing of Al-alloys. In present study oxide particles are purposely introduced. The oxide particles are formed of AL_2O_3 / $Mg\dot{O}$. The apparent stress exponent for steady-state creep rate n_a, is increases with decreasing applied stress.

The examination by TEM (Transmission Electron Microscopy) showed that the present of frequent interaction between Nano-scale particles and dislocation and morphology of the particles represent associated with the Al-oxides, the shape of the particles is nearly spherical, the average size of particles is nearly 30nm for grade with .3% oxygen and 35nm for grade with 1% oxygen, the distribution of particles in the samples is not uniform and density of particles in 1% oxygen is higher then .3% oxygen. The creep behaviour of Al solid solution alloys can be represented by power law creep of the form $\gamma = A\left(\frac{\tau}{G}\right)^{n}\exp\left(\frac{-Q_C}{RT}\right)$. The creep behaviour of Al solid-solution alloy exhibits three region of deformation. Region 1 is low stress region, region 2 is Intermediate stress region and region 3 is high stress region. The present experimental data show that creep behaviour of the two grades of PM 2014 Al differ from that of Al-based solid solution alloys. It this investigation it has been assumed that nearness of a threshold stress controls the clear downer conduct of an Al-based strong arrangement composite yet does not impact the beginning and nature of yield mechanism. The creep power law equation can be modified as

$$\gamma = A\left(\frac{\tau - \tau_0}{G}\right)^{n}\exp\left(\frac{-Q}{RT}\right)$$

The apparent creep behaviour of PM 2014 Al is characterized by stress exponent and activation energies that are high and variable. The threshold stress for creep is the interaction between the dislocation and oxide particulate which introduced in alloy by PM Process. The characteristic of the threshold stress is its temperature dependence. Its magnitude increases with increasing the volume fraction of oxides.

Fatigue Test:

Failures occurring under conditions of dynamic or alternating loading are called fatigue failures, apparently on the grounds that it is by and large seen that these failures happen simply after an impressive time of service. Fatigue failure usually occurs at stresses well below those required for yielding, or in some cases above the yield strength but below the tensile strength of the material. These failures are dangerous because they occur without any warning. Typical machine components subjected to fatigue are auto-mobile crank-shaft, bridges, aircraft landing gear, etc. failures happen in both metallic and non-metallic materials and are in charge of a huge number part of identifiable service failures of metals. It is the dynamic and restricted auxiliary harm that happens when a material is subjected to cyclic loading.

A fatigue failure can be perceived from the presence of the crack surface, which demonstrates a smooth and cleaned surface that relates to the moderate development of cracks, when the cracks faces smoothen out by steady rubbing against one another and a harsh/granular locale compares to the phase of quick development, after critical conditions is achieved where part has failed in a ductile way when cross area was not any more ready to convey the connected load. The region of a fracture surface that formed during the crack propagation step may be results in characteristic pattern of concentric rings spread over the smooth region of the fracture surface, known as beach marks or striations, radiating outward from the point of initiation of the failure.

Three basic requisites for occurrence of fatigue fracture are:

1) a maximum tensile stress of sufficiently high value.
2) a large enough changes or deviation in the applied stress.
3) a enough number of cycles of applied stress.

The stress cycles that are evident in fatigue studies are characterized using many parameters, such as mean stress, alternating stress, stress ratio and amplitude ratio. If the applied stress varies between σmax and σmin,

1. Range of stress, σr = σmax – σmin
2. Alternating stress, σa = σr/2 = (σmax – σmin)/2
3. Mean stress, σm = (σmax + σmin)/2
4. Stress ratio, R= σmin / σmax
5. Amplitude ratio, A= σa / σm = (1-R) / (1+R)

Experimental Procedure:

1) Polish the sample surface as smooth as possible and observe for any surface defects and deep scratch/machining marks. Reject the sample if you find any defects.
2) Measure dimensions of the given specimen of mild steel.
3) Place the test-specimen is in the sample fixture such that it passes through the opening provided in the rod on which the loads are placed.
4) After placing the sample, keep the desired load on the place provided for the loads.
5) On the instrument to start the fatigue test and record the time for the failure, when it occurs.
6) Record the appearance of the fractured surface in each situation.

Apparatus:

1) Specimen with the correct design
2) Vernier callipers
3) Dead weight as load
4) Wrench for fitting the bolt of specimen holder

Specimen Preparation:

Testing specimen was prepared according to the American Standard Testing Materials (**ASTM-E466 - 15**) as shown in figure 1.

Figure 1: Fatigue Test Specimen

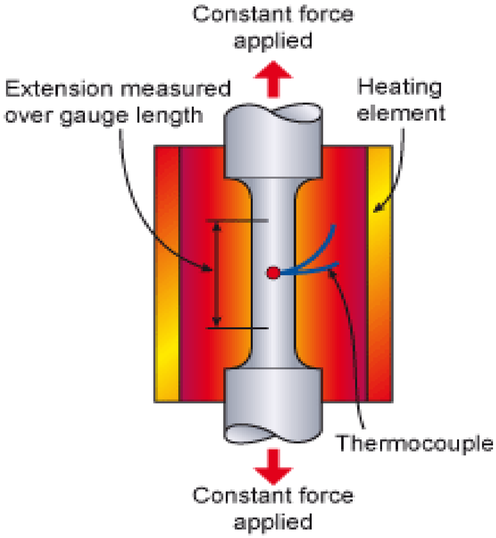
Creep Test:

Creep may be defined as a time-dependent deformation at elevated temperature and constant stress. The temperature at which creep begins depends on the alloy composition. It should be pointed out that the actual operating stress will, in part, dictate or determine the temperature at which creep begins. For carbon steel creep begins at 800°C and for stainless steel it begins at 1050°C.

The creep occurs when a component is held under constant load less then elastic load at constant temperature which leads to the creep. As the name suggests this is a slow failure mechanism. For most purposes such movements are of little or no importance. Increasing the temperature, in any case, builds the rate of deformation at the connected load and it is fundamentally essential to know the speed of deformation at a given load and temperature if parts are to be securely intended for high temperature benefit. Inability to have the capacity to do this may result in, for instance, the untimely failure of a pressure vessel or the fouling of gas turbine on the turbine casing.

The creep test:

1) Tensile test-specimen to which a uniform stress is applied, normally by the simple method of suspending weights from it.
2) Around the specimen is a thermostatically operated furnace, the temperature being operated by a thermocouple attached to the gauge length of the specimen.
3) The elongation of the test-specimen is calculated by a very sensitive extensometer since the real amount of elongation before failure may be only two or three per cent.
4) The outcome of the test are then plotted on a graph of strain versus time.



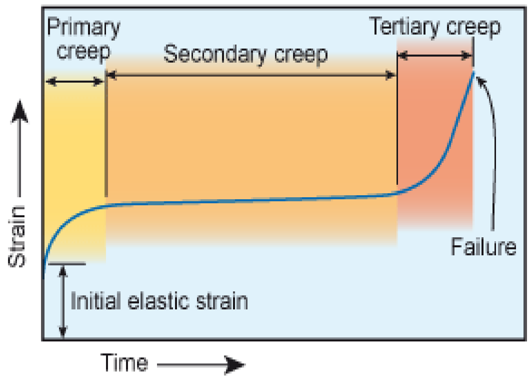


Figure 2: Creep Test

The above diagram illustrate that creep failure occurs in three different phases - a sudden increase in length known as primary creep where the creep rate decline as the metal work hardens. This is ensue by a period of aapproximately uniform creep rate, steady state or secondary creep and it is this period that forms the bulk of the creep life of a component. The third stage, tertiary creep, occurs when the creep life is almost diminished, pores have appeared in the material and the effective cross-sectional area has been declined.

The test specimen ddimensions and design is based on a standard tensile specimen. It has to be proportional in order that outcomes can be compared and ideally should be machined to higher tolerances than a standard tensile test piece. In general the straightness of the specimen should be maintained to within some ½% of the diameter. A slightly out of shape specimen for instance bent will introduce bending stresses that will seriously affect the results. The surface finish is also important - the specimen should be smooth, scratch free and not cold worked by the machining operation. The extensometer should be placed on the gauge length and not to any of the other load carrying parts as it is difficult to separate any extension of these parts from that in the specimen.

II. CONCLUSION

Particulate reinforced metal matrix composites are widely used in military and aerospace applications. Several matrix materials are available as a matrix. Among all the metal matrix composites aluminium based metal composites are finding more applications. Micro particulates like Al_2O_3, graphite; B_4C, TiC, TiO_2 and WC can be used as the reinforcements. In processing of aluminium metal matrix composites, several techniques like solid and liquid state methods are used. Among all the fabrication techniques liquid stir casting process is the more simpler and economical one. Addition of reinforcements usually enhances the properties of aluminium alloys. Fatigue and creep properties are important for certain aerospace applications.

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