

## Retraction

# Retracted: Mechanical Strength and Fatigue Fracture Analysis on Al-Zn-Mg Alloy with the Influence of Creep Aging Process

### Advances in Materials Science and Engineering

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.





The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] M. Ponnusamy, B. P. Pulla, T. Sathish et al., "Mechanical Strength and Fatigue Fracture Analysis on Al-Zn-Mg Alloy with the Influence of Creep Aging Process," *Advances in Materials Science and Engineering*, vol. 2021, Article ID 1899128, 5 pages, 2021.

## Research Article

# Mechanical Strength and Fatigue Fracture Analysis on Al-Zn-Mg Alloy with the Influence of Creep Aging Process

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The Al-Zn-Mg alloy comes under the aluminium alloy; it possesses good capability of age hardening and superior strength in contrast to other alloys. The numbers of creep aging experiments are conducted with the support of different temperature levels such as 180, 200, and 2000°C. The effects of tests are reflected on the tensile test and fatigue tests; the temperature and stress directly affects the creep characteristics, mechanical strength, and fatigue performance of the Al-Zn-Mg alloy. The time period of the creep test is maintained as 15 hrs with constant load of 200 MPa and 220 MPa. The increasing temperature increases the tensile strength and fatigue life of the Al-Zn-Mg alloy under initial condition; furthermore, continuous increment reduces the strength and fatigue existence. In the fatigue test, the fatigue span of the Al-Zn-Mg is extremely enhanced by the application of creep aging at a particular temperature. The 3D profilometry image visibly shows the influence of temperature in forming a fracture in fatigue analysis through microstructure analysis.

## 1. Introduction

Creep aging is one class of forming process with merger of creep deformation and aging of material, both improve the material properties and life time of working. This creep aging process concentrated on fabrication of aircraft panels and more integral parts [1–3]. Creep aging is a precision forming, used to reduce the fracture while the material is processed. Most of the research conducted creep aging process to analyse and improve the microstructures and mechanical properties. Creep aging process is a method of heat treatment in the forming process with creep action; the material

for creep aging is loaded in elastic nature in a gripper. The loaded elastic material is kept in a temperature set for a predetermined time period [4, 5]. The constant load and under in thermal exposure of the material elements of the metal are undergone to impulsive and change of microstructure and the mechanical properties of the Al-Zn-Mg alloy. From the creep aging process, the change of the material properties and the spring back effects of the materials are easy to control [6]. The materials containing aluminium alloys and combination of elements such as copper, magnesium, and zinc are used in the industry. These alloys are developed by heat treatments; furthermore, these

alloys are used as special purpose alloys or high-effective performance alloys [7, 8]. In heat treatment, the atoms huddle and slide within the aluminium matrix, for these atomic changes improve the mechanical strength as well as hardness of the alloys. In this work, we carry out creep aging process on the Al-Zn-Mg alloy with different thermal exposures and different creep loads to evaluate the tensile strength of the material and the fatigue fracture [9–11].

## 2. Materials and Properties

The aluminium alloys include more zinc compared to magnesium; few of the alloys have less than one zinc and magnesium. The casings and wrought components are formed by the Al-Zn-Mg alloys; these alloys have less castability character. The zinc and magnesium are the major constituent elements of the Al-Zn-Mg alloys; with the increasing ratio of the zinc, the magnesium ratio offered superior strength and flexible for heat treatment process [12, 13]. The low contribution ratios introduce excellent weldability. The chemical composition of each element is tabulated in Table 1.

**2.1. Experimental Procedure.** The specimens are prepared for the creep test, as shown in Figure 1, and the specimens are sized from the plate as per the standards (ASTM E139) using wire cut EDM machine [14].

Initially, the specimens are tested in the tensile testing machine and the tensile value is found; conducting the initial test, the plot of stress-strain curve is obtained, as illustrated in Figure 2. The initial tested samples offered the tensile values: tensile strength is 430 MPa and the yield strength is 325 MPa; the test was conducted by using nine samples.

**2.2. Creep Aging Process.** The creep aging was conducted on the selected specimens with applied of the constant stress values are 0 MPa, 200 MPa, and 220 MPa, respectively; the selected temperature levels are 180°C, 200°C, and 220°C, respectively. The aging time period maintained for all specimens is 15 hours. Each specimen is tested before it is cleaned well and the wet nature removed. The specimen before entering the testing chamber can be weighted to identify the creep behaviour after the creep aging process is finished. The specimen is mounted in between upper and lower hook rigidity with the aid of mounts; the lower end is connected to constant load. The hanging position of the sample is surrounded by the selected temperature level for the purpose of heat treatment process, and the entire arrangement is kept at a selected time period such as 15 hours [15]. The creep aging setup is clearly illustrated in Figure 3.

**2.3. Tensile Testing and Fatigue Testing.** After creep aging, the specimens were tested using the tensile testing machine, the model of VENUS Tech Pvt, and the capacity of testing machine was 40 ton with computerized operation. The fatigue test was conducted by using the sine-wave loading arrange model machine effectively; all the specimens

TABLE 1: Chemical composition range of Al-Zn-Mg alloys.

Material	Wt.% of composition
Zn	2–8
Mg	0.5–4
Cu	0–3
Fe	0.1–0.8
Si	0.05–0.3
Cr	0.0–0.5
Mn	0.0–1.5
Ti	0.0–0.5
B	0.0–0.05
Zr	0.0–0.25
Ag	0.0–1.0
Be	0.0–0.10
Other elements	<0.05 each



FIGURE 1: Typical creep aging sample.

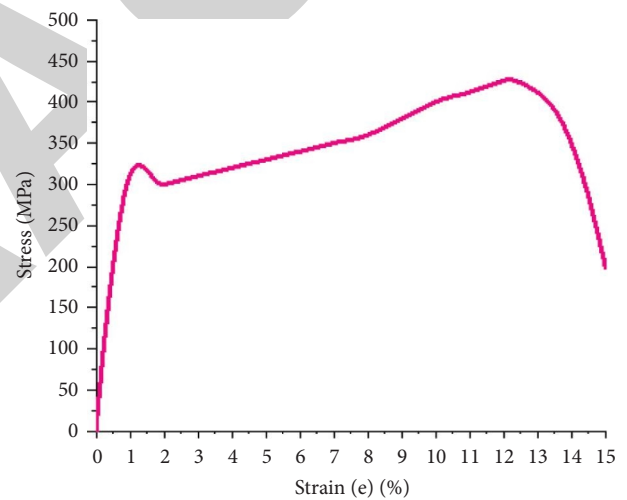


FIGURE 2: Stress-strain curve of the initial sample.

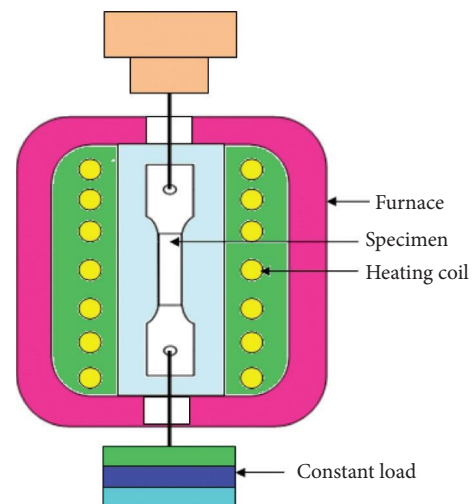


FIGURE 3: Creep aging arrangement.

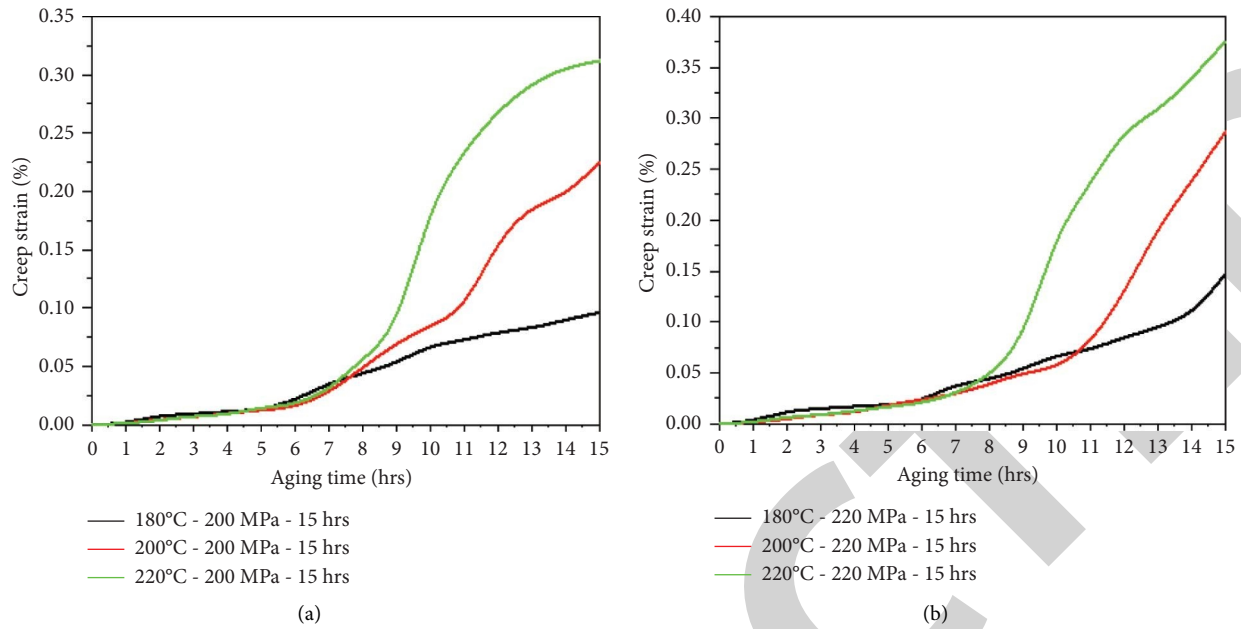


FIGURE 4: (a) Creep aging graph, aging time vs. creep strain (200 MPa). (b) Creep aging graph, aging time vs. creep strain (220 MPa).

underwent the fatigue test with a range of the stress ratio value as 0.1 (40/400 MPa). The fatigue test loading frequency was selected as 15 Hz using a fatigue testing machine at room temperature.

### 3. Results and Discussion

**3.1. Creep Analysis of Alloy.** Figure 4(a) shows the aging time with the creep strain graph visibly; the Al-Zn-Mg alloy was tested at different levels of temperature with 200 MPa; stress concentration was measured. The aging time was continually increased and stopped at 15 hours; under such a condition the creep curve shows a steady state. Figure 4(b) illustrates the aging time with the creep strain graph applying 220 MPa, and both the graphs shows an increase of temperature the creep strain steadily increased.

Table 2 presents the creep strain of the Al-Zn-Mg with a variety of temperature levels and stress levels. With the increase in temperature, 180°C, under the applied stress of 200 MPa, the creep strain rate was increased as 0.096% at the same temperature stress which varied as 220 MPa; the creep strain obtained was 0.146%. With the influence of temperature, 200°C, with applied stress of 200 MPa, the creep strain was attained as 0.225%; with the same temperature but with increase of stress, 220 MPa, the creep strain was attained as 0.288. With the increase of temperature from 180°C to 220°C, the stress was maintained at 200 MPa and the creep strain was acquired as 0.312; furthermore, with the increase of the stress value, 220 MPa, but with the same temperature, the creep strain was increased to 0.375.

**3.2. Mechanical Strength of Al-Zn-Mg Alloy.** Applying orthogonal test in the Al-Zn-Mg alloy after creep aging, the mechanical strength was analysed and presented in Table 3, clearly. Table 3 effectively illustrates that the aging

TABLE 2: Creep strain with a variety of aging temperature and stress values.

Temperature (°C)	Stress (MPa)	Creep strain in %
180	200	0.096
	220	0.146
200	200	0.225
	220	0.288
220	200	0.312
	220	0.375

temperature was highly influenced to change the mechanical properties. With the temperature level from 180°C to 200°C, the tensile strength and the yield strength increased; further increase of temperature at the level of 220°C, decreased tensile strength and yield strength continually.

**3.3. Influencing of Aging Temperature on Fatigue Analysis of the Al-Zn-Mg Alloy.** Figure 5 plainly shows the fatigue analysis of the alloy with constant stress, 200 MPa, after creep aging with 15 hrs time period. This graph shows the constant stress level at 180°C aging temperature; the moderate value, such as 56,347 cycles, is obtained; furthermore, with increase in temperature, 200°C, and with constant stress, the high fatigue cycles were attained as 81,358. With high temperature, 220°C, and with constant stress, the fatigue cycles were decreased to 32,562.

**3.4. Influence of Stress on Fatigue Analysis of the Al-Zn-Mg Alloy.** Figure 6 shows the fatigue analysis of alloy with different stress levels after creep aging of 15 hrs at constant temperature of 200°C. For not applied of stress, the fatigue level of the alloy is 25,682 cycles for 15 hrs of aging; furthermore, increasing the stress level to 200 MPa, increases

TABLE 3: Mechanical strength of Al-Zn-Mg alloy after creep aging.

Temperature (°C)	Stress (MPa)	Tensile strength (MPa)	Yield strength (MPa)	Elongation %
180	0	442.76	312.75	18.23
	200	468.48	340.21	20.12
	220	465.38	331.49	20.34
200	0	463.19	390.68	11.75
	200	490.63	410.23	11.37
	220	487.34	408.39	12.02
220	0	423.15	356.42	9.34
	200	432.89	386.81	9.64
	220	438.67	391.59	9.82

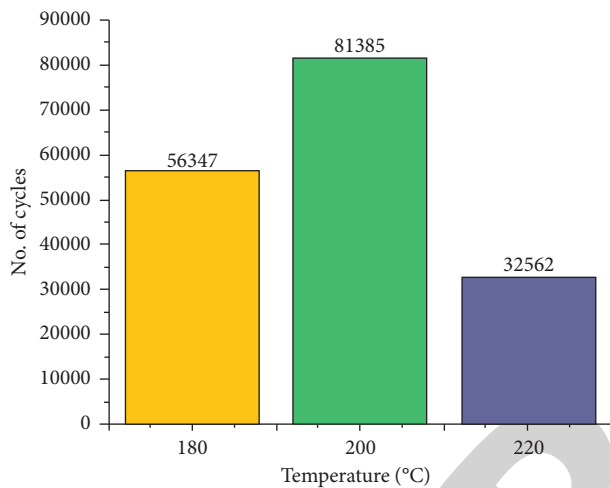


FIGURE 5: Fatigue analysis of the alloy with constant load after creep aging of 15 hrs.

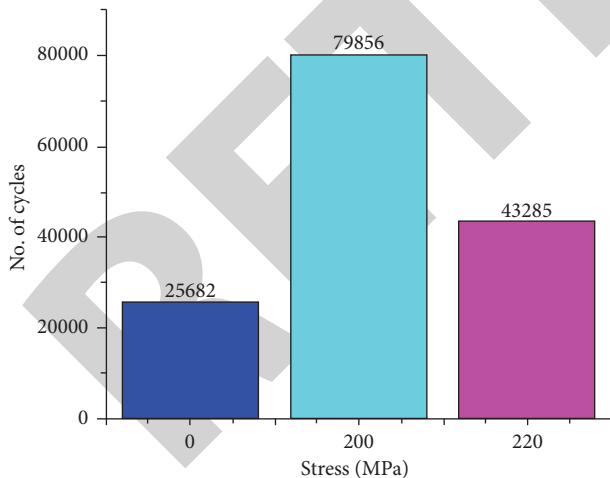


FIGURE 6: Fatigue analysis of alloy with different stress levels after creep aging of 15 hrs.

the fatigue life to 79,656 cycles. The highest stress 220 MPa applied the fatigue life was decreased.

#### 4. Conclusion

The Al-Zn-Mg alloy was fabricated, and the creep aging was carried out successfully through the heat treatment process.

Applying constant stress and implementing varying temperature effectively, the tensile strength and fatigue analysis was carried out, and the result was clearly pointed out as follows:

- (i) the increase of temperature, 180°C, under the applied stress of 200 MPa, the creep strain rate increased was 0.096% at the same temperature stress which varied as 220 MPa; the creep strain obtained was 0.146%. With the influence of temperature, 200°C, with applied stress of 200 MPa, the creep strain was attained as 0.225%. With the increase of temperature at 180°C to 220°C, the stress was maintained as 200 MPa; the creep strain was acquired as 0.312; furthermore, the stress value increased as 220 MPa, but in the same temperature, the creep strain increased as 0.375.
- (ii) The temperature level increases from 180°C to 200°C; the tensile strength and the yield strength were increased, but further increasing temperature to 220°C, tensile strength and yield strength were decreased continually.
- (iii) From the 180°C of aging temperature, the moderate value such as 56,347 cycles was obtained; furthermore, with increase of temperature, 200°C, with constant stress, the high fatigue cycles were attained as 81,358. When temperature is 220°C with constant stress, the fatigue cycles decreased as 32,562.
- (iv) Fatigue analysis of alloy with different stress levels after creep aging of 15 hrs at constant temperature of 200°C is carried out. For not applied of stress, the fatigue level of the alloy is 25,682 cycles for 15 hrs of aging; furthermore, increasing the stress level to 200 MPa, the fatigue life was increased as 79,656 cycles. When the highest stress 220 MPa is applied, the fatigue life is decreased.
- (v) Future scope of this study is extended to increase the strength of the alloys by applying reinforcements and is further planned to conduct the wear and corrosion test.

#### Data Availability

The data used to support the findings of this study are included within the article. Further data or information are available from the corresponding author upon request.

## Disclosure

This study was performed as a part of the Employment Bule Hora University, Ethiopia.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

## Acknowledgments

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