IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.53

Volume 4, Issue 3, October 2024

The Compression Measureo Aluminium Material at Distinctive Strain Rate

Ajay Kumar Verma, Mohit Kumar Thakur, Rohit Kumar Singh, Sanjay Kumar Yadav, Prem Kumar Singh, Sumit Kumar Yadav & Sonu Yadav

Department of Mechanical Engineering

K. K. Polytechnic, Dhanbad, India

Abstract*: Using powdered graphite combined with machine oil as a lubricant throughout the tests, compression tests of aluminum alloy at various strain rates were conducted on a universal testing machine at room temperature and under various strain rates ranging from 0.01/s to 0.15/s. In order to draw the genuine stress-strain curve for varying strain rates, which shows the mechanical properties of the metal for industrial applications, true stress and strain values were computed using the engineering equation.*

Keywords: Compression, True Stress, True Strain, Regression Analysis

I. INTRODUCTION

The properties of materials under crushing loads are ascertained via a compression test. Deformation under different stresses is observed after the sample is compressed. A stress-strain diagram, which is used to calculate the elastic limit, proportional limit, yield strength, and yield point, was created by plotting the calculated compressive stress and strain. Compression tests are crucial because they aid in determining the various material characteristics that apply to both hot and cold metal forging used in various metal forming applications. Finding the right load to perform the processes becomes crucial. The materials and flow stress determine the load. By establishing a link between flow stress, strain, and strain rate, one may ascertain the flow behavior of aluminum at various strain rates. A specimen may deform when a compressive load is applied; for brittle materials, this may result in crushing or fracture, while for ductile materials, it may be the result of elastic or plastic deformation.

Different Properties of Aluminium:-

Aluminum has a special set of qualities that make it ideal for a wide range of applications. It is a very practical and appealing building material.

- **WEIGHT:** Compared to other materials like steel, aluminum is the lightest. It weighs 2.700 kg/m³.
- **STRENGTH:** The tensile strength of aluminum ranges from 70 to 700 MPa. The alloying ingredients and manufacturing technique determine its strength.
- **LINEAR EXPANSION:** The coefficient of linear expansion for aluminum is comparatively high.
- **ELASTICITY:** Al has a Young's modulus (E = 70,000 MPa), which is one-third that of steel.
- **FORMABILITY:** The formability of aluminum is good. The rolling of strips and foils takes advantage of this feature whether working with hot or cold metal.
- **MACHINABILITY:** It is very easy to machine aluminum. It is possible to produce aluminum using both hot and cold processes.
- **JOINING:** All of the various techniques, including welding, soldering, adhesive bonding, and riveting, can be used to join aluminum.
- **REFLECTIVITY:** Heat and visible light are best reflected by aluminum.
- **CORROSION RESISTANCE:** Aluminum is extremely resistant to corrosion and produces a protective oxide covering. It can be applied in situations when conservation and protection are necessary.
- **CONDUCTIVITY:** Al is a very good heat and electrical conductor. An analogous Cu conductor weighs twice as much as an Al conductor.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, October 2024

- **NON-TOXIC:** Because aluminum is non hazardous, it can be used both for food preparation and storage.
- **NON-MAGNETIC SUBSTANCE:** One such material is aluminum. To prevent magnetic field interference, Al is utilized in magnet X-ray devices.

II. EXPERIMENT DETAILS

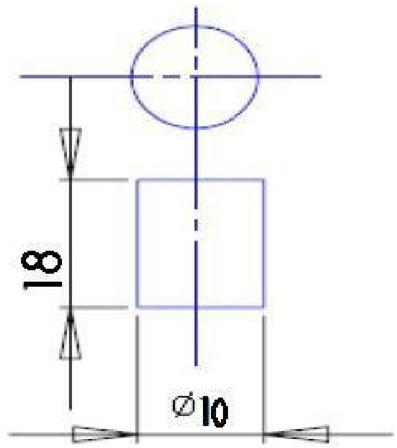
The INSTRON SATEC 600 KN universal testing machine was used for the investigations. INSTRON's 600 KN models are perfect for high capacity shear, flex, compression, and tension testing. Because it can accommodate a wide range of specimen sizes, grips, fittings, and extensometers, this design provides the utmost versatility. These models have a very big single test space and are very easy to use for loading and unloading specimens in a safe and easy manner. Among the models are the following: 300, 600, 1200, 1500, 2000, and 3500K.

Table 2.1 Specifications of INSTRON SATEC 600 KN

Maker	Instron,UK
Software	Bluehill Em Console
Type	Hydraulic
Max. Loading Capacity	600 Kn
Max. Vertical Test Opening	1625 Mm
Actuator Stroke	508 Mm
Load Accuracy	±0.5% Of Reading Down To 1/500 Of Load Cell Capacity
Strain Accuracy	±0.5 Of Reading Down To 1/50 Of Full Range

Figure 2.1 Instron Satec

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, October 2024



Compression Test to be conducted requires the testing of 15 Specimens prepared from the raw aluminium rod.
Specimen Specifications:
L/Deff 1.6 for to assure a geometrical dimensional factor and homogeneous deformation
L = Length of the Specimen
Deff = Effective Diameter of the Cross Section of the Specimen
Hence if
Deff =10 mm, L should be approximately 15 mm
In the current experiment,
L has been taken as 18 mm
Specimens of the required dimensions were cut from the aluminium. Alloy bar using hacksaw and facing operation was carried out to Make the two ends parallel by the lathe machine.
To create the lubricant for the test, machine oil and graphite powder were combined in the right proportion. One of the carbon allotropes is graphite. A hexagonal molecular structure with layers supported by weak Van der Waal forces is formed by the covalent bonding of one carbon atom to three other carbon atoms in graphite. The layers can readily slide over one another because the Van der Waals forces between them are weaker. It can therefore be applied as a lubricant. The bonding is weaker because carbon atoms are farther apart between planes. For lubricating, graphite works best in a typical environment. Graphite is primarily divided into two types: synthetic and natural.
In order to prevent the specimen from being forged to the anvil and ram at high temperatures, graphite lubricant is used.

III. RESULT & DISCUSSION

True strain and stress curves were acquired when the aluminum alloy was compressed at strain rates ranging from 0.01 to 0.15/s. As the strain rate increases, so do the peak and flow stresses. The stress-strain curve is shown to increase steadily until plastic deformation takes place if the true stress based on the specimen's actual cross-sectional area is employed. The curve is referred to as a real stress-strain curve if the strain measurement is also based on instantaneous measurement. Fitting mathematical equations to this curve has been attempted numerous times. The most popular way to express power is in the form of

$$\sigma = A \times \epsilon^{n}$$

Where,
σ = true stress,
A is strength coefficient,
n is the strain hardening exponent.
Using the true stress and true strain data stored in the computer's database, the BLUEHILL software integrated with the UTM machine instantly creates the flow curve for every specimen following the experiment. It creates the flow curves using the engineering equation.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, October 2024

IV. FLOW CURVE

FOR STRAIN RATE 0.01/S

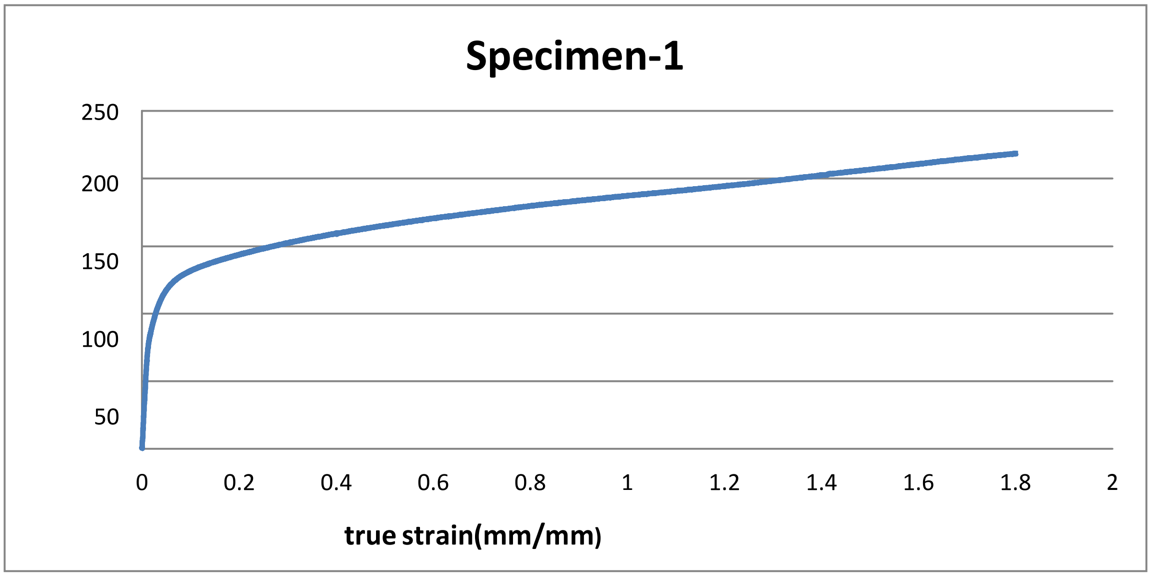


Figure 3.1 Variation of true stress with true strain at 0.01 strain rate

FOR STRAIN RATE 0.02/S

Figure 3.2 Variation of true stress with true strain at 0.02 strain rate

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, October 2024

FOR STRAIN RATE 0.03/S

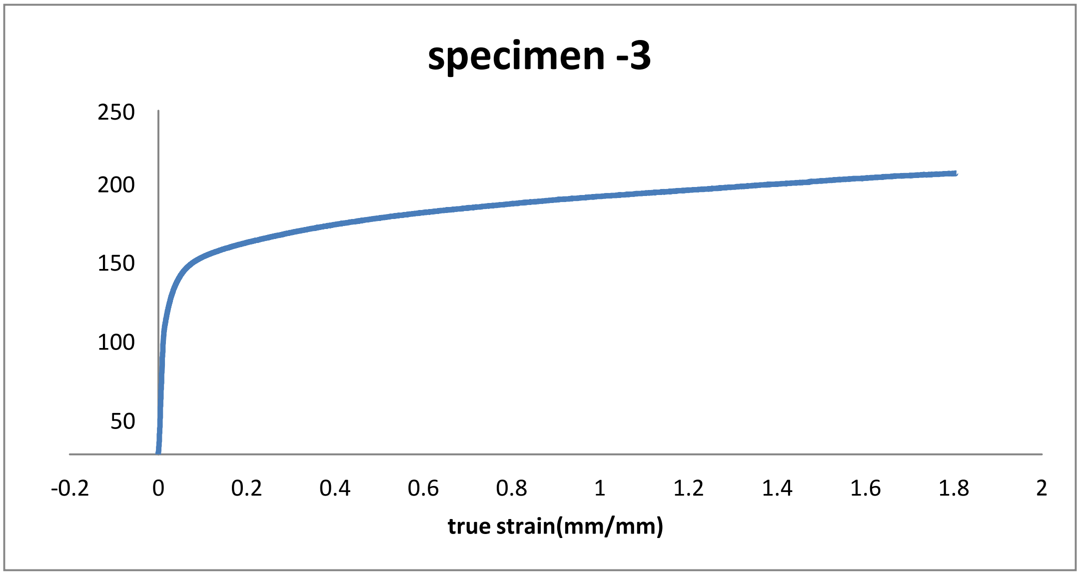


Figure 3.3 Variation of true stress with true strain at 0.03 strain rate

LINEAR REGRESSION ANALYSIS

Modeling and analyzing variables that show the mathematical link between a dependent variable and one or more independent variables is done with regression analysis. Numerous methods have been developed to perform regression analysis. The most widely utilized of these are least squares regression and linear regression. Linear and non-linear least squares problems are the two types of least squares problems. The primary distinction between the nonlinear and linear least squares is that the former has a closed-form solution while the latter does not.

Regression analysis is used to define the flow stress behavior of the material by generating a mathematical link between true stress and true strain. A power expression of the form is the most prevalent.

$$\sigma = m\dot{\epsilon} + C$$

This equation represents the straight line y= mx+c, which can be used to find the maximum stress at different value of strain rate.

Graph should be linear but due to less accuracy graph is nonlinear.

$= m\ \dot{}\ + \mathrm{C}$

$150 = (0.011) + c$

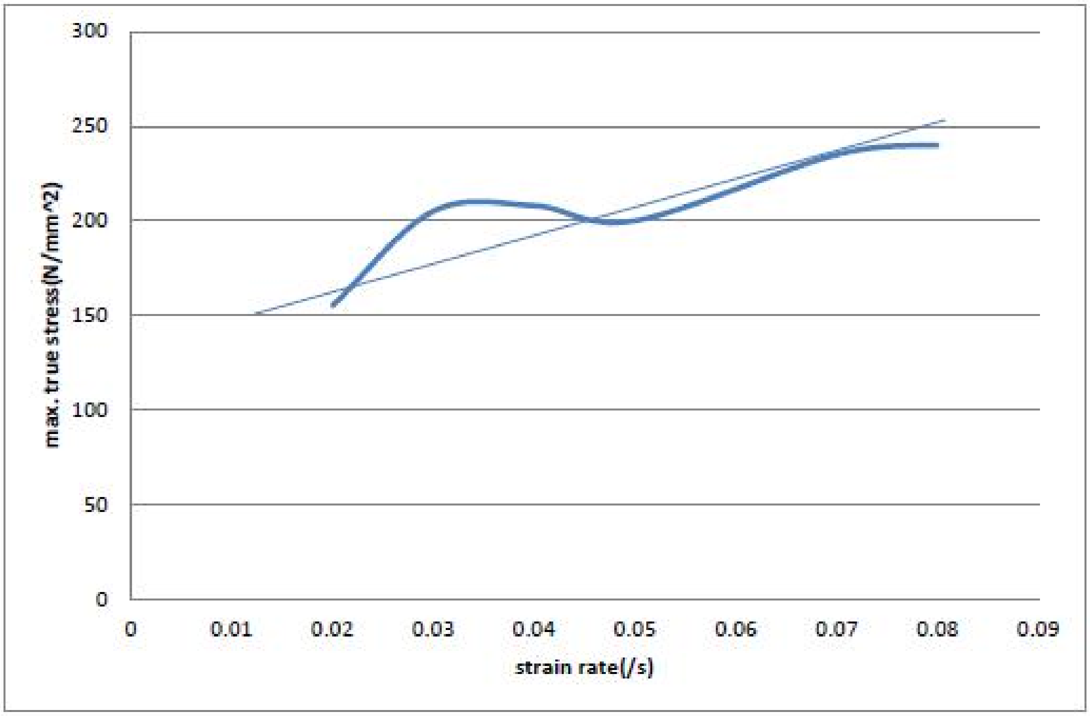
$200 = (0.047) + c$

After solving equation

$m = 1387.9$

$n = 132.2$

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, October 2024



The findings led to the following conclusions:
As genuine strain reduces, so does true stress.
The strain and strain determine the strain hardening component.
For the current aluminum material, the linear equation E=1387.9 Ç+ 132.2 can be used to illustrate the increase of stress with strain rate.
It is discovered that the relationship between stress and strain rate is unpredictable. The experimental error could be the cause.

REFERENCES

[1]. Hui Zhang, Luoxing Li, Deng Yuan, Dashu Peng Hui Zhang, Luoxing Li, Deng Yuan and Dashu Peng, "Hot deformation behavior of the new Al–Mg–Si Cu aluminium alloy during compression at elevated temperatures", Materials Characterization 58, (2007), pp. 168–173.
[2] Nengping Jin, Hui Zhang, Yi Han, Wenxiang Wu, and Jianghua Chen, "Hot deformation behavior of 7150 aluminium alloy during compression at elevatedtemperature", Materials characterization 60 (2009), pp. 530-536.
[3] M.R. Rokni, A. Zarei-Hanzaki, Ali A. Roostaei ,and H.R. Abedi, "An investigation into the hot deformation characteristics of 7075 aluminum alloy",Materials and Design 32 (2011),pp. 2339–2344.
[4] Xudong Huang, Hui Zhang,., Yi Han, Wenxiang Wu,and Jianghua Chen, "Hot deformation behavior of 2026 aluminum alloy during compression at Elevated temperature", Materials Science and Engineering a 527 (2010),pp.485–490.
[5] Ying Deng, Zhimin Yin, and Jiwu Huang, "Hot deformation behavior andmicrostructural evolution of homogenized 7050 aluminum alloy during compression at elevated temperature", Materials Science and Engineering A528 (2011),pp. 1780–1786.
[6] Jiang Li, Fuguo Li, Jun Cai, Ruiting Wang, Zhanwei Yuan, and FengmeiXue, "Flow behavior modeling of the 7050 aluminum alloy at elevated temperatures Considering the compensation of strain", Materials and Design 42 (2012),pp. 369–377.

[7] ZHANG Zhi-ye, PAN Qing-lin, ZHOU Jian, LIU Xiao-yan, CHEN Qin, "Hot deformation behavior and microstructural evolution of Al..Zn..Mg..0.25Sc..Zr alloy during compression at elevated temperatures".
[8] R. Kaibyshev, O. Sitdikov, I. Mazurina, D.R. Lesuer , "Deformation behavior of a 2219 Al alloy", Materials Science and Engineering A334 (2002)104–113.