Astrit Imeri - ABOUT ME

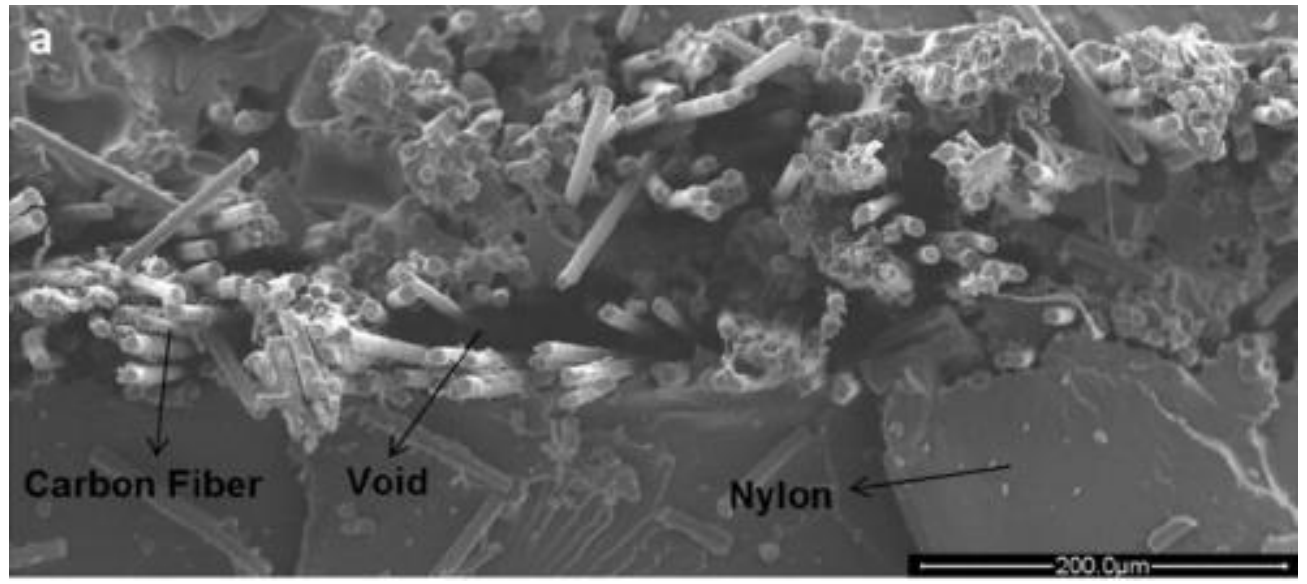
I am currently a Ph.D. candidate in Mechanical Engineering at Tennessee Technological University where I work under Center for Manufacturing Research. I am planning to graduate in August 2023.

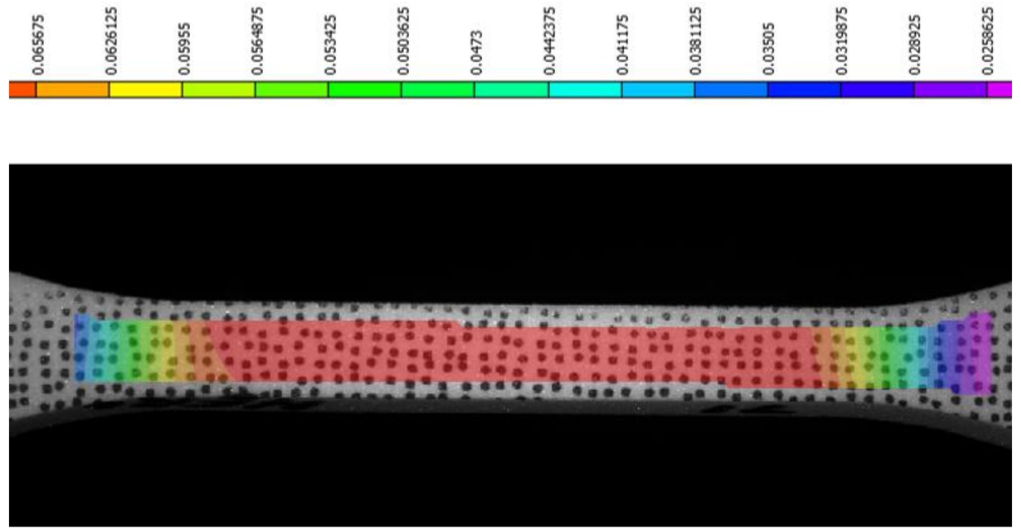
I received a M.Sc. in Mechanical Engineering from Tennessee Technological University in 2017 and B.Sc. in Mechanical Engineering from Middle East Technical University in 2016.

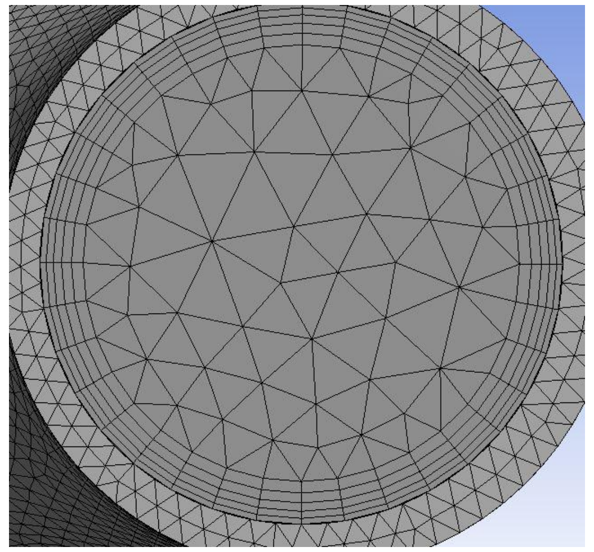
I have a deep passion for mechanical engineering. I am curious about learning how things work and behave in order to improve them.

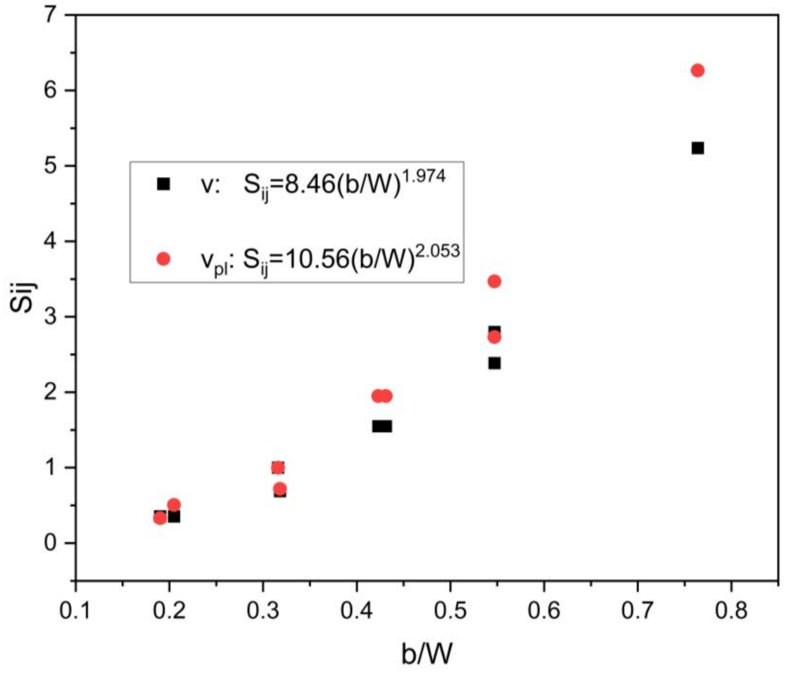
Throughout graduate school, I had the opportunity to work on various projects that included mechanical testing, materials characterization, 3D printing, and numerical methods programming.

This portfolio contains summaries of projects that I have worked on as well as some of the publications I have co-authored.









Property Optimization of Fiber-reinforced Additively Manufactured Nylon

Fall 2016 – Spring 2018

Problem Statement

- Examined the effect of fiber reinforcement material (carbon fiber, fiberglass, and Kevlar) to 3D printed Nylon for tensile, fatigue, and creep properties
- Several fiber orientations patterns were tested for tensile and fatigue properties
- The failure mechanisms were analyzed and disclosed using Scanning Electron Microscope
- Performed statistical analysis, ANOVA and linear regression, for fatigue and creep results, respectively

Procedure

- Specimens were 3D printed using Markforged Mark Two
- ASTM D638 was used for tensile testing at 5mm/min and specimens were tested until failure
- ASTM E606 geometry was used for fatigue testing at 1Hz, with a tension-tension ratio of R=0.1
- Rectangle specimens were tested under constant pressure at room temperature and 100°C for 60 minutes, then released for another 60 minutes
- Fiber infill orientations were divided into three groups: Concentric (fiber around the perimeter),isotropic(fiber at 0° angle in the whole layer area), and combination of concentric rings and isotropic infill

Results

- The highest resistance to tensile strength were the carbon fiber reinforced specimens with isotropic infill 0° angle with two concentric rings
- For fatigue testing, carbon reinforced specimens with isotropic infill 0° angle with one concentric ring endured the highest number of cycles (10000+)
- Due to fiber discontinuity tensile specimens failed at the shoulder of the dogbone
- Fiber pull-out, delamination, and fiber-breakage were found to be the main failure mechanisms
- Creep properties were improved the most by addition of carbon fiber
- Norton/Bailey statistical model was found to be the best for fitting model

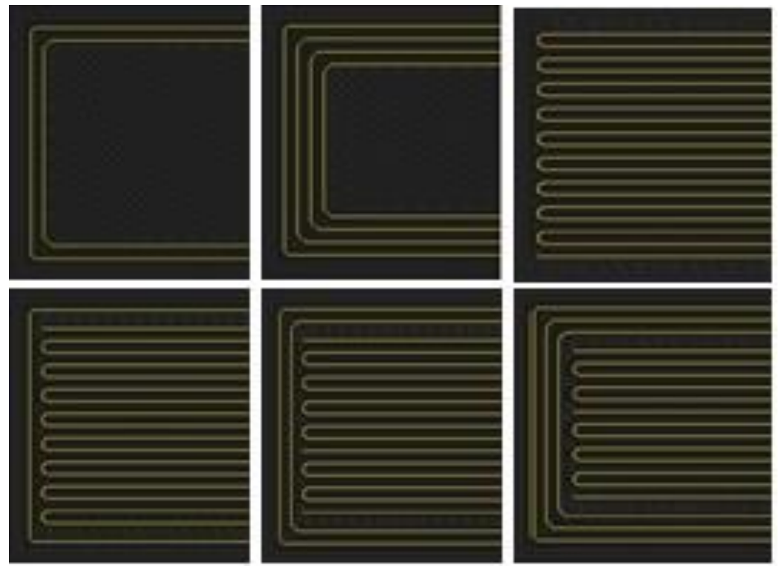


Figure 1: Infill types for 3D printed tensile and fatigue specimens

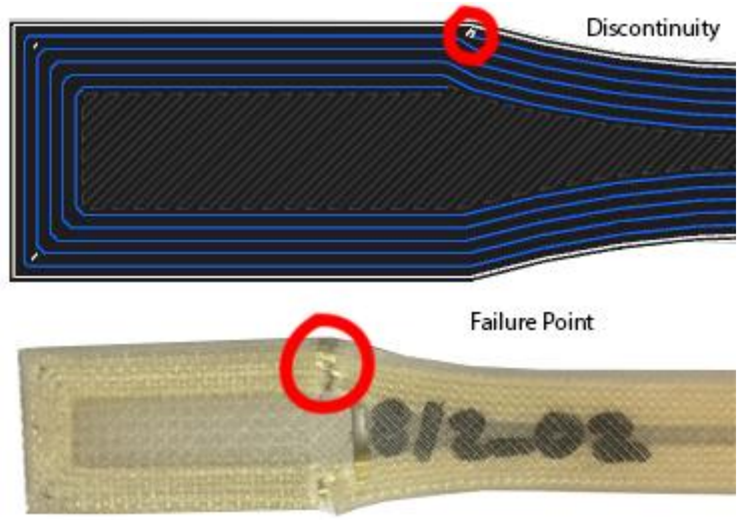


Figure 2: Failure due to discontinuity of the fiber at the shoulder

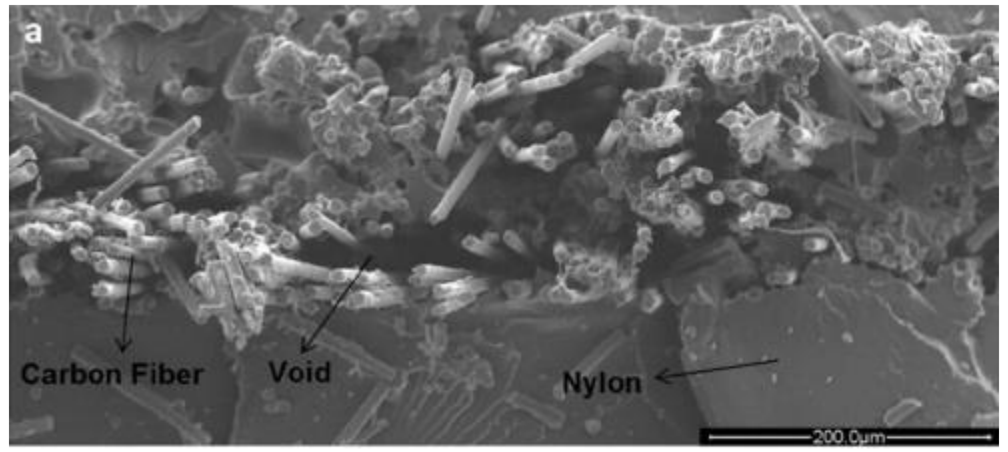


Figure 3: SEM image of 3D printed carbon fiber reinforced Nylon after fatigue test

Bi-modulus behavior evaluation in high performance commercial foam used

Fall 2022

Problem Statement

- Commercial foam supplied by the manufacturer was tested with the goal of understanding whether it exhibited bi-modulus behavior
- Tensile, compression, and torsion specimens were tested in order to evaluate the modulus
- Digital Image Correlation (DIC) was used for displacement and strain fields
- Data was compared with previous values sourced from manufacturer

Procedure

- For DIC analysis specimens were rolled with black ink pattern kit
- To establish the testing rate, tensile specimens were tested to fail under 60 seconds; then same rate was used for compression and torsion
- Tension and compression tests were performed using Instron 5569
- Geometry measurements were performed at three different locations for all specimens
- To evaluate the homogeneity of specimens, various virtual extensometers and areas of interest were analyzed using DIC

Results

- Poisson's ratio was found to be 0.284
- From DIC, due to the uniformity of the strain field in the tensile test, material was considered as homogenous
- Tensile modulus: Et=118.164 Mpa; St.Dev=9.992
- Compression modulus: Ec=160.951 Mpa; St.Dev=6.151
- Torsion modulus assuming material was not bi-modulus derived from $G = \frac{E}{2(1+v)}$: E=154.08 MPa
- Because torsion machine was manually controlled by the operator, which cause large stress relaxations due to viscoelasticity behavior of the material, more tests will be conducted

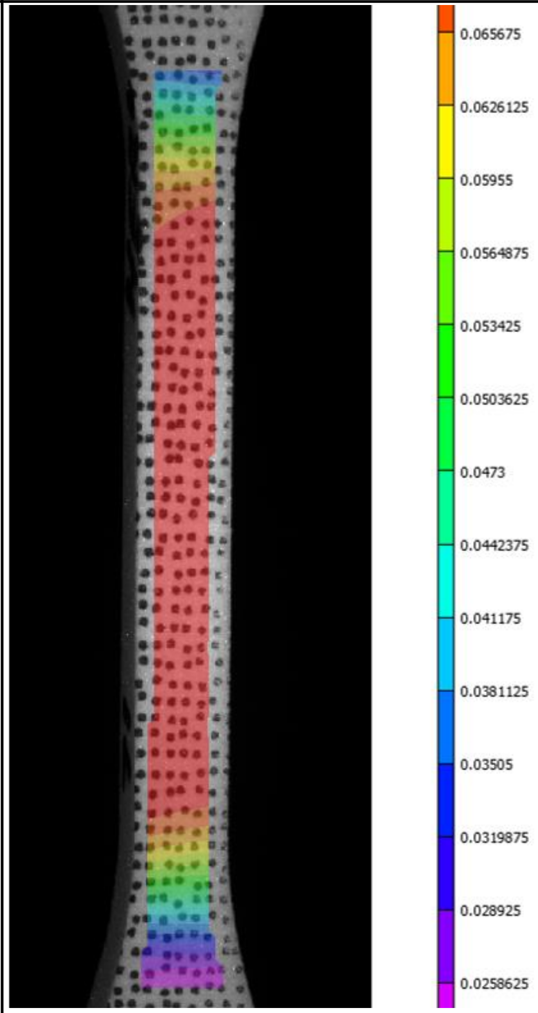


Figure 1: Fully developed strain field for the tensile specimen

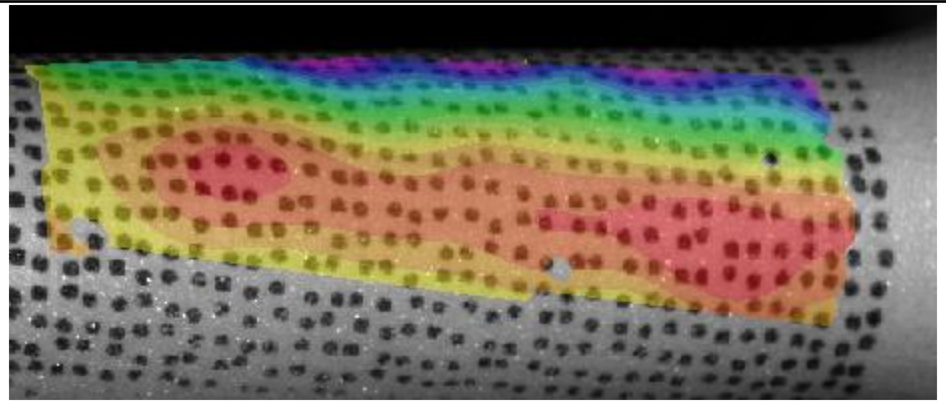


Figure 2: Strain field of the torsion specimen

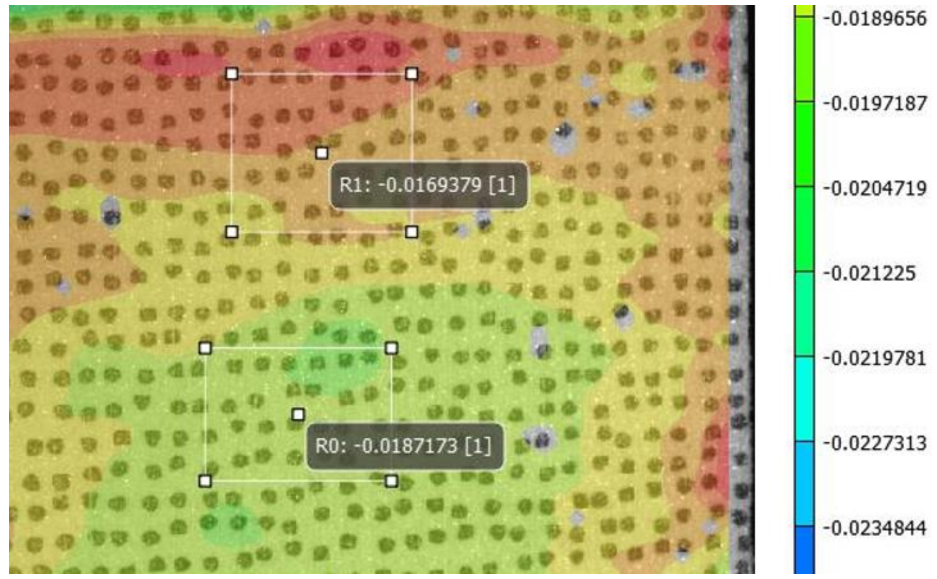


Figure 3: Strain fields and various regions of interest for the compression specimen

Application of Fracture Mechanics Theories to Additively Manufactured Polymers	Fall 2021 – Spring 2023

Problem Statement

- Applied the load separation method to evaluate the fracture toughness
- Evaluated the work factor η and plastic work factor η_{pl} using total displacement and plastic displacement approaches, respectively
- The theory was tested for FDM 3D printed materials such as ABS, ASA, and PC
- Unidirectional infill was used for the 3D printed specimens, 0° and 90°,respectively
- To the best of my knowledge, this theory was not applied to 3D printed polymers before

Procedure

- 9mm thick rectangular sheets were 3D printed using Raise 3D E2 3D printer
- Three point bending single-edge notched specimens were cut out using waterjet cutter Flow Mach 200, to avoid the effects of the contour layers to unidirectionality in 3D printing
- Specimens were loaded at 2mm/min rate in a Test Resources 810 universal tester
- Digital Image Correlation (DIC) was used for load-displacement records
- Specimens with crack notch length to width (a/W), varying from0.2 to 0.8,were tested

Results

- For all of the materials, in both infill directions, η_{pl} value was found to be close to 2.0, which is in agreement with the values for ductile metals and conventionally manufactured polymers
- The values for η were found to be close to 2 as well; however marking the region where the load separation method was valid is not as straight-forward due to the elastic-plastic behavior of the materials
- Self-similarity condition for the whole range of a/W was not fulfilled, meaning that the curves do not resemble to each other
- For a/W closer to 0.5, pop-in phenomenon was noticed, and crack changed directions by 90°
- Data for η_{pl} and η was fitted using power law

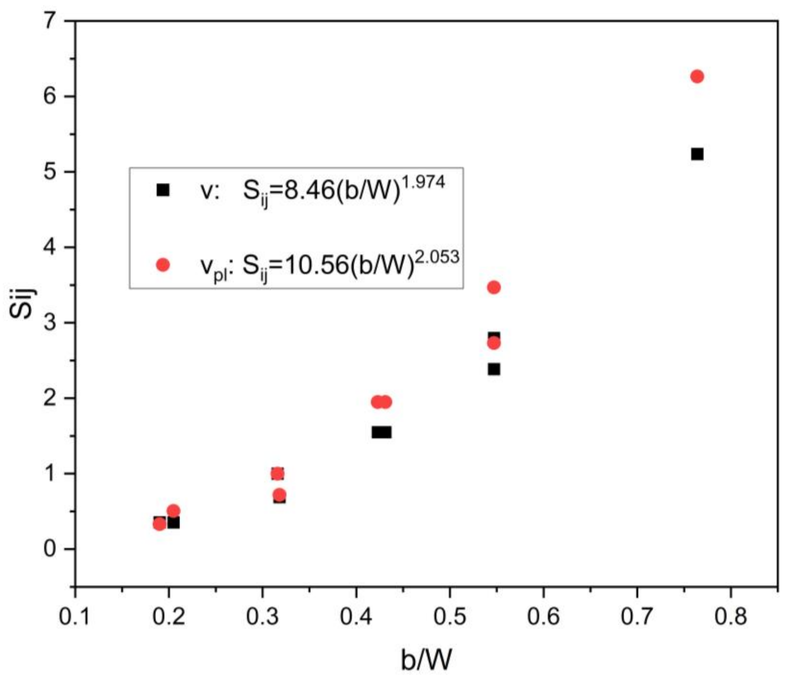


Figure 1: Evaluation for η_{pl} and η using power law fit for ABS with 0° infill

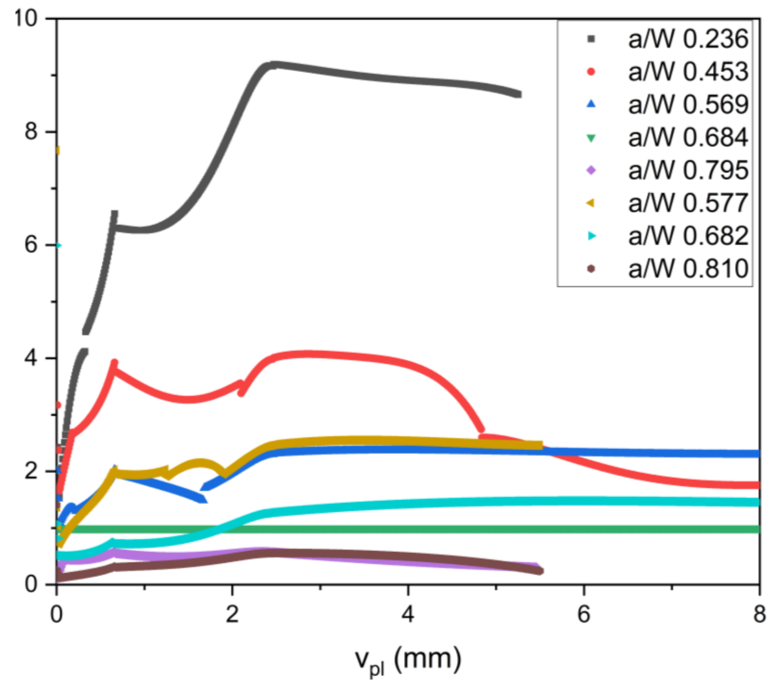


Figure 2: Sij vs v_pl graph for ABS with 0°, where Sij is the ratio between two specimens with different a/W

CFD: Numerical Study of Pressure Losses in Close-coupled Fittings	ME7090 – Spring 2019

Problem Statement

- The goal was to reproduce the results from Sami and Cue(2004) in ANSYS/Fluent, by using laminar flow for the following conditions :
  - Flow in straight pipe
  - Flow in one-elbow fitting
  - Flow in two-elbow fittings – U-shaped
- Another goal was to do a parametric study to understand the effect of Reynolds number and the effect of the lengths for the inlet and outlet pipe

Procedure

- In ANSYS, the geometry was modeled using Design Modeler
- Meshing was done by applying 10 degree inflation with smoothing set to high
- Additionally, mesh sizing of 0.08 was applied to the elbow surfaces

- Friction factor was calculated using the following formula: $f = \frac{\Delta P}{\frac{L}{D2}\frac{1}{2}\rho U_{avg}^2}$
- Pressure loss was calculated using the following formula:
- $C = \frac{p2-p1}{\frac{1}{2}*\rho*U_{avg}^2} - f(D1 + D2)$, where D1 and D2 represent the distances before and after entering the elbow

Results

- Friction factor for flow in a straight pipe was found by trial and error f=0.69, 7.8% higher than the experimental value, still within 10% range
- For flow in one-elbow fitting, the loss coefficient was calculated to be 1.046
- For two-elbow fitting with 0D distance separation, the loss coefficient was calculated to be 3.54
- Results for 3D two elbow fittings parametric study on Reynolds number are as follow:

Reynolds number	f_experimental	f_ansys	Error (%)	C
10	6.4	6.39	0.16	11.84
100	0.64	0.69	7.8	2.57
200	0.32	0.397	12.4	1.93

- Increasing Reynolds number(increasing velocity) decreases the pressure loss coefficients

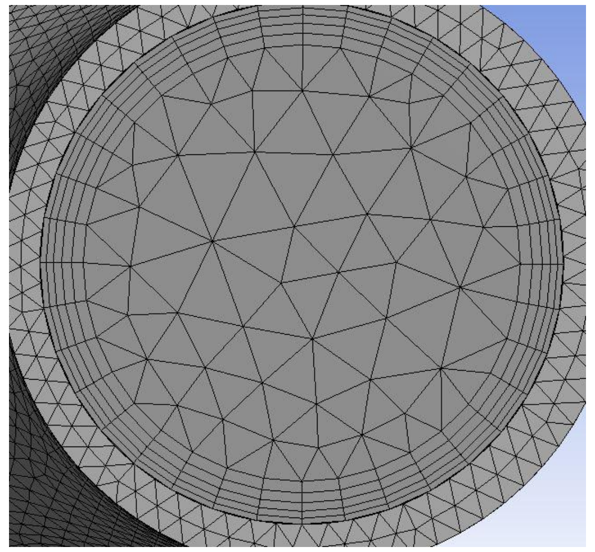


Figure 1: Cross-section of the pipe, and different meshing regions

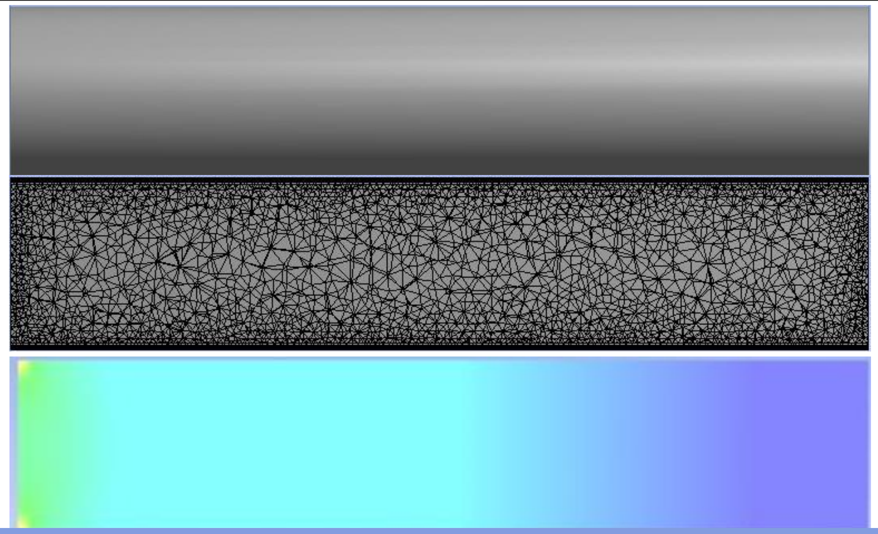


Figure 2: The 5D straight pipe, mesh, and pressure distribution

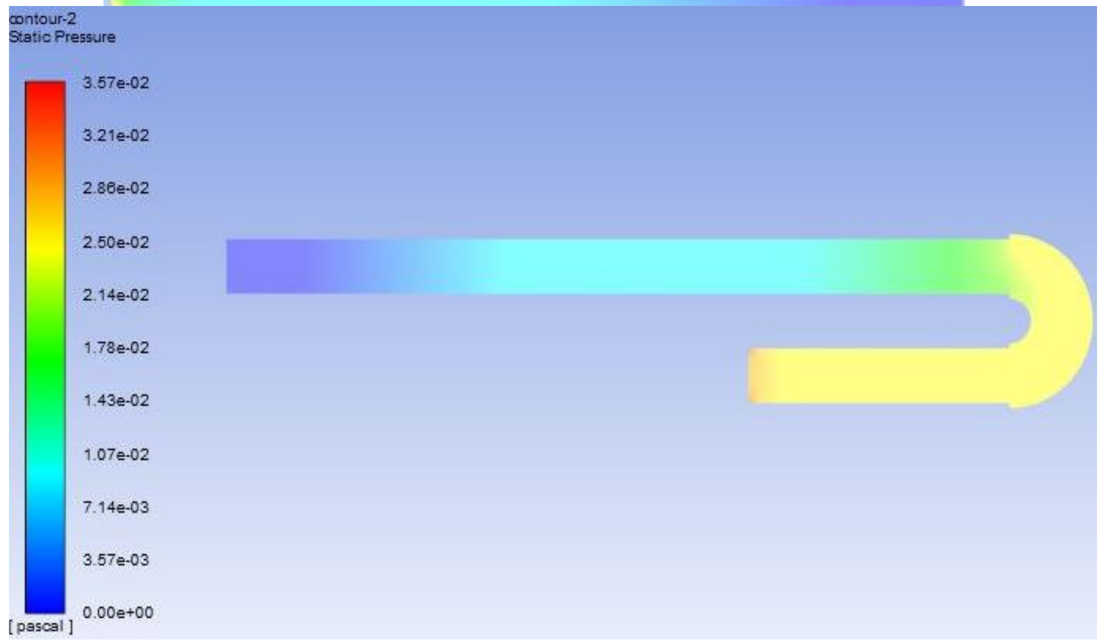


Figure 3: Pressure distribution for the 0D two-elbow fitting

PUBLICATIONS

Google scholar: https://scholar.google.com/citations?user=QMGzAloAAAAJ&hl=en&oi=ao

BOOK CHAPTER:

- **Imeri.A.** & Fidan.I (2020). Fatigue behaviors of fiber-reinforced composite 3D printing. In *Fatigue Life Prediction of Composites and Composite Structures (Second Edition)* (pp. 335-348). Lausanne, Lausannee: Woodhead Publishing Series in Composites Science and Engineering. doi:https://doi.org/10.1016/B978-0-08-102575-8.00009-7

JOURNALS:

- **A. Imeri**, I.Fidan, M.Allen, D. Wilson, S. Canfield "Fatigue Analysis of the Fiber Reinforced Additively Manufactured Objects", International Journal of Advanced Manufacturing Technology, 2018.
- Chen, Y., Rios, C.O., **Imeri, A**., Russell, N.A. and Fidan, I., 2020. Investigation of the tensile properties in fibre-reinforced additive manufacturing and fused filament fabrication. *International Journal of Rapid Manufacturing*, *9*(2-3), pp.251-267.
- Mohammadizadeh, M., **Imeri, A**., Fidan, I. and Elkelany, M., 2019. 3D printed fiber reinforced polymer composites-Structural analysis. *Composites Part B: Engineering*, *175*, p.107112.
- Fidan, I., **Imeri, A**., Gupta, A., Hasanov, S., Nasirov, A., Elliott, A., Alifui-Segbaya, F. and Nanami, N., 2019. The trends and challenges of fiber reinforced additive manufacturing. *The International Journal of Advanced Manufacturing Technology*, pp.1-18.
- Mohammadizadeh, M., Fidan, I., Allen, M. and **Imeri, A**., 2018. Creep behavior analysis of additively manufactured fiber-reinforced components. *The International Journal of Advanced Manufacturing Technology*, *99*(5-8), pp.1225-1234.

CONFERENCES:

- **A.Imeri**, C.D. Wilson "Applicability of Load Separation Methods to Additively Manufactured ABS". In *International Design Engineering Technical Conference and Computers and Information in Engineering Conference(IDETC/CIE2023),* under review, American Society of Mechanical Engineers, Boston, MA, August 20-23, 2023
- **A.Imeri**, I. Fidan, M. Allen, G.Perry "Effect of Fiber Orientation in Fatigue Properties of FRAM Components" 2018 NAMRC Conference and Transactions of SME/NAMRC, in press, Texas A&M University, Texas, June 18-22, 2018.
- Fraley, J., **Imeri, A**., Fidan, I. and Chandramouli, M., 2018, July. A Comparative Study on Affordable Photogrammetry Tools. In *ASEE Annual Conference proceedings*.
- **A. Imeri**, N. Russell, J. R. Rust, S. Sahin, I. Fidan, "MAKER: 3D Pen Utilization in 3D Printing Practices," *Proceedings of the 2017 ASEE Annual Conference*, Columbus, OH, June 25-28, 2017.
- **A. Imeri**, N. Russell, J. R. Rust, S. Sahin, I. Fidan, "MAKER: 3D Printing as an Alternative to Fabricate the Motorsports Parts," ***Proceedings of the*** *2017 ASEE Annual Conference*, Columbus, OH, June 25-28, 2017.

ACHIEVEMENTS

- Kandy Thevar International Graduate Student Scholarship May 2022 – (1500$ award)
- SME Educational Awards – Nashville Chapter 2017-2018 Winner – (1500$ award)
- NSF ATE Student Award for Excellence (October, 2017)
- Innovation and Second Place Awards in the Maker Competition at 2017 SME Golden Eagle Manufacturing Day Summit (October 2017)
- NSF Travel Award to NAMRC 46 (April 2018)
- Registration Grant to NSF ATE PI Conference (Octorber 2017)
- "The trends and challenges of fiber reinforced additive manufacturing," published in 2019 in *The International Journal of Advanced Manufacturing Technology*, has received **131 citations** to date. For all articles published in the category of Materials Science in 2019, the average number of citations is only 18.65. This article is thus one of the **top 10% most-cited articles published in Materials Science in 2019**.
- "3D printed fiber reinforced polymer composites-Structural analysis," published in 2019 in *Composites Part B: Engineering*, has received **121 citations** to date. This article is thus one of the **top 10% most-cited articles published in Materials Science in 2019**.
- "Fatigue analysis of the fiber reinforced additively manufactured objects," published in 2018 in *The International Journal of Advanced Manufacturing Technology]*, has received **50 citations** to date. For all articles published in the category of Materials Science in 2018, the average number of citations is only 23.82. This article is thus one of the **top 20% most-cited articles published in Materials Science in 2018**.
- "Creep behavior analysis of additively manufactured fiber-reinforced components," published in 2018 in *The International Journal of Advanced Manufacturing Technology*, has received **51 citations** to date. This article is thus one of the **top 20% most-cited articles published in Materials Science in 2018**.

Technical Reviewer:

- SN Applied Science
- MDPI Journal of Composites Science,
- International Journal of Rapid Manufacturing, IJRapidM,
- North American Manufacturing Research Conference, NAMRC 47