SIMATS ENGINEERING

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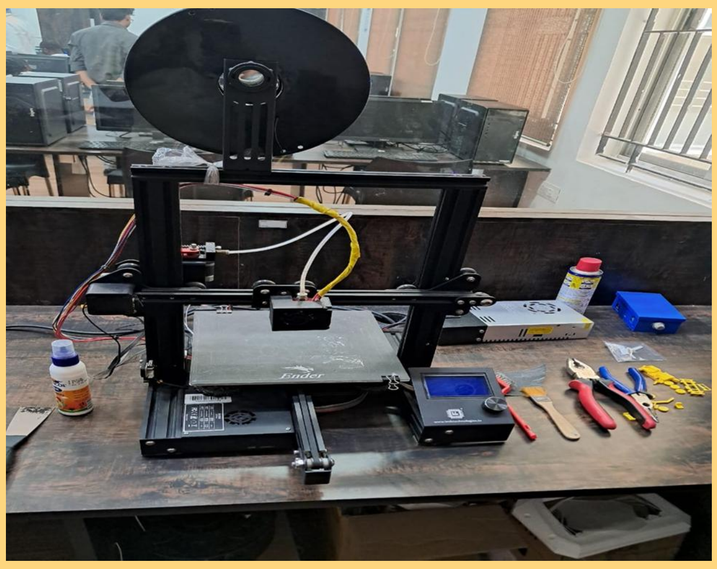
Name: Ms. DV. SAI KUMAR
Register Number: 192372321
Guided by Dr. A. VASUDEVAN

Comparison of Bending Strength in 3D-Printed Nylon Filament Composites with Various Infill Patterns Using a CNN Approach

INTRODUCTION

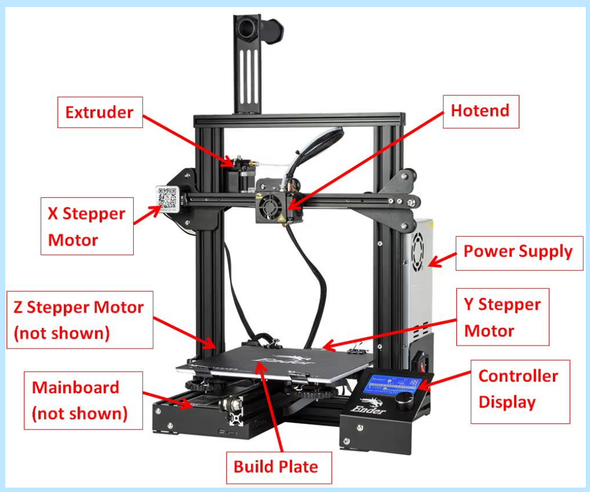
- In recent years, the advancements in 3D printing technology have opened up new possibilities in material engineering, manufacturing, and design.
- Nylon filament is particularly prized for its strength, flexibility, and resistance to wear, making it a preferred choice for a wide range of applications, from industrial components to consumer products.
- The mechanical properties of 3D-printed objects, such as bending strength, can be significantly influenced by factors like the infill pattern selected during the printing process.
- This paper outlines the methodology used to prepare the filament samples, the design and training of the CNN, and the validation of the model against experimental data.
- "This study employs a CNN approach to analyze bending strength in 3D-printed nylon filament composites with different infill patterns.“.



FDM (fused deposition modeling)

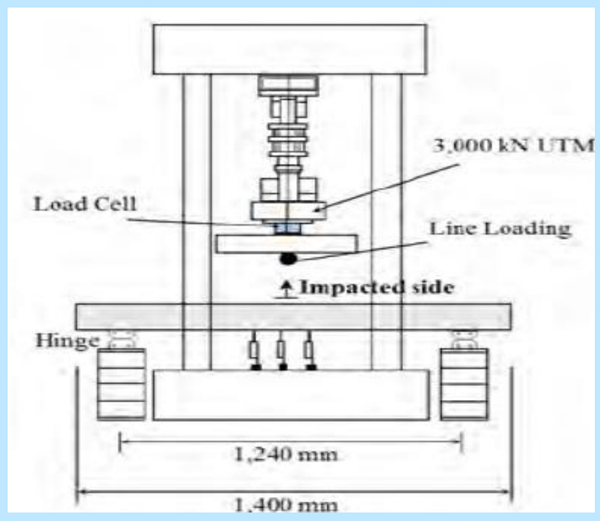
MATERIALS AND METHODS

Nylon 3D Printer Filaments



A schematic of the FDM printing process

3D Printed Nylon Filament Plates



Flexural test setup

RESULTS

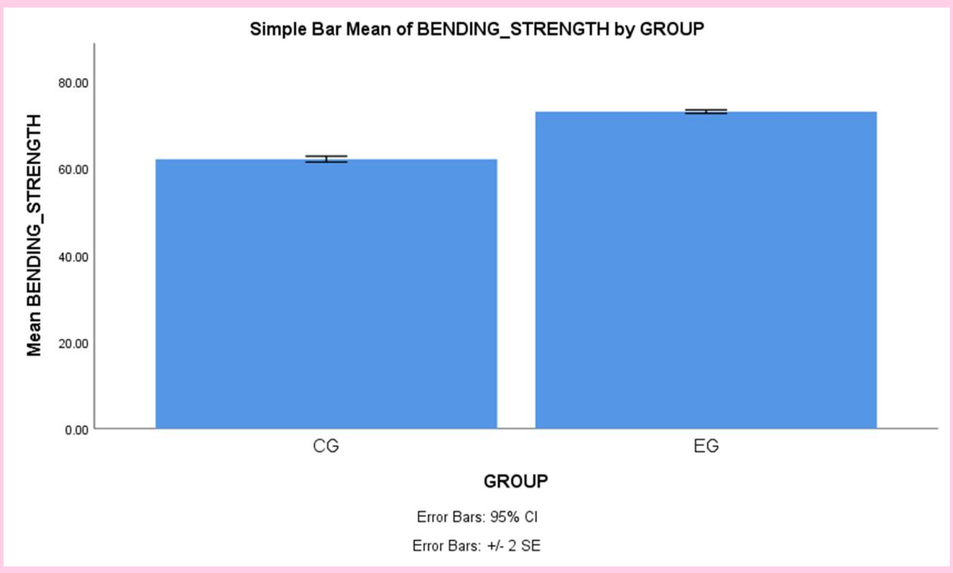


Fig. Bar Chart representing the comparison of Bending Strength for CG and EG represents Nylon

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Bending strength	Equal variances assumed	6.149	0.018	-27.477	38	0.000	-10.95000	0.39852	-11.75676	-10.14324
	Equal variances not assumed			-27.477	30.971	0.000	-10.95000	0.39852	-11.76281	-10.13719

Table: Independent sample T-Test for Tensile Strength for analysis of samples for Bending Strength for Nylon

DISCUSSION AND CONCLUSION

- Based on T-test Statistical analysis, the significance value of p=0.001 (independent sample T - test p<0.05) is obtained and shows that there is a statistical significant difference between the group 1 and group 2.
- Overall , the accuracy of the tensile strength is 68.95 % and it is better than the line infill pattern.
  - Control group mean difference tensile strength of = 56.4 (MPa)
  - Experimental group mean difference tensile strength of = 62.2 (MPa)
  - Obtained p-value = 0.009
- The T-test Statistical analysis resulted in a significant p-value of 0.001 (independent sample T-test p<0.05), indicating a statistically significant difference between group 1 and group 2.
- This study embarked on the investigation of optimizing bending strength in 3D-printed Nylon plates through various infill patterns, utilizing an Artificial Neural Network (ANN) to model and predict the mechanical outcomes.
- Our findings reveal significant insights into how different infill configurations affect the structural integrity of Nylon components, and demonstrate the viability of using ANN as a powerful tool for predicting and enhancing mechanical properties in 3D printing.

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