Topology Optimization for Additive Manufacturing

Kazybek Kassym, 2nd year MAE MSc student

INTRODUCTION

The current rising of effectiveness in AM has contributed to increased production of complex mechanical parts with minimum material waste. The interests of manufacturers are focusing on exploring the complex shapes that can reduce the weight of the component. Topology optimization uses computer software and to do material layout modification by removing material from the design space.

AIM

To assess the use of topology optimization methods in additive manufacturing in combination with the effect of 3D-printing parameters on the resulting strength of the printed objects

OBJECTIVES

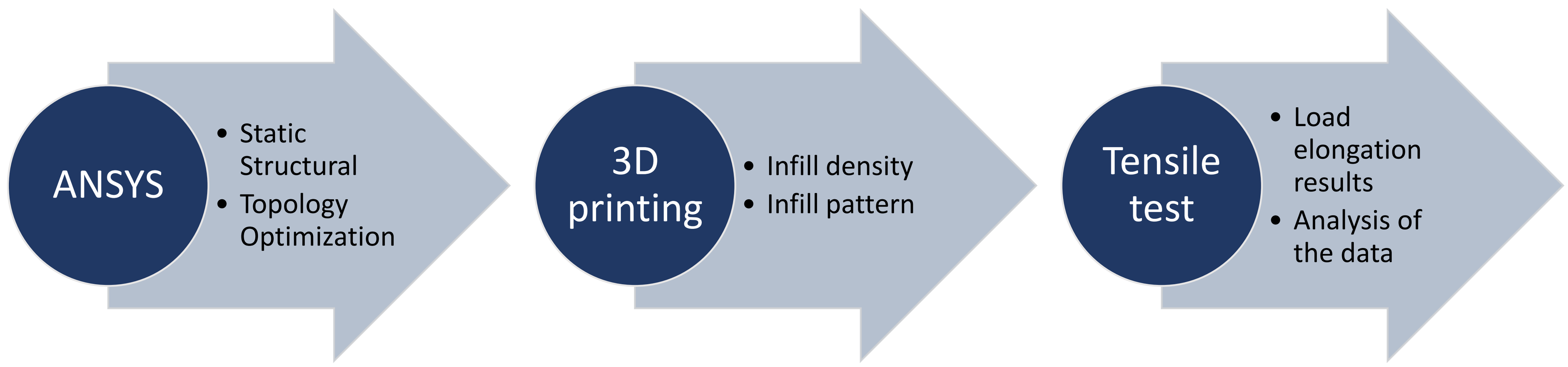
Produce optimized design of the specimen using two various methods.

Print the accurate optimized prototypes with various infill density and infill pattern.

Analyze the results of the experiment.

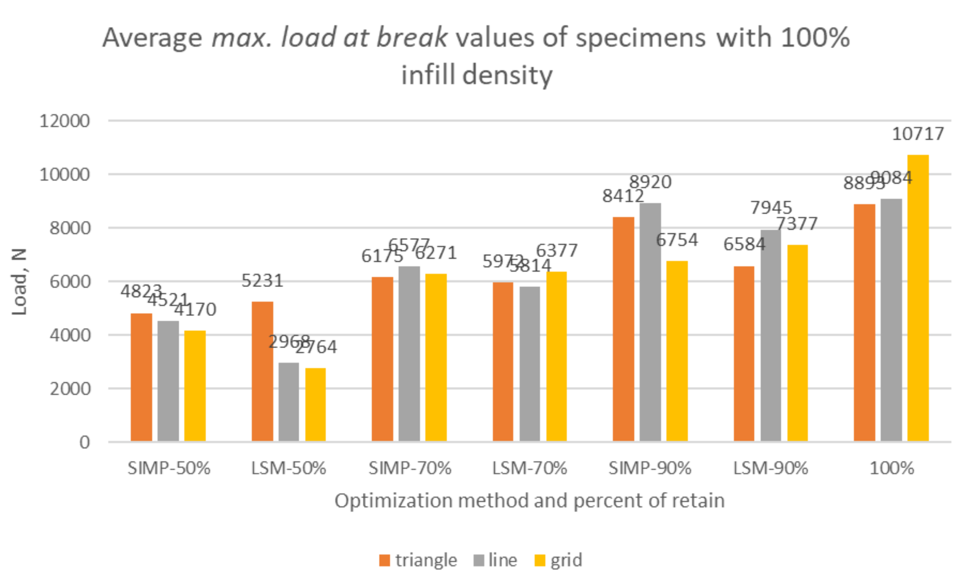
METHODOLOGY

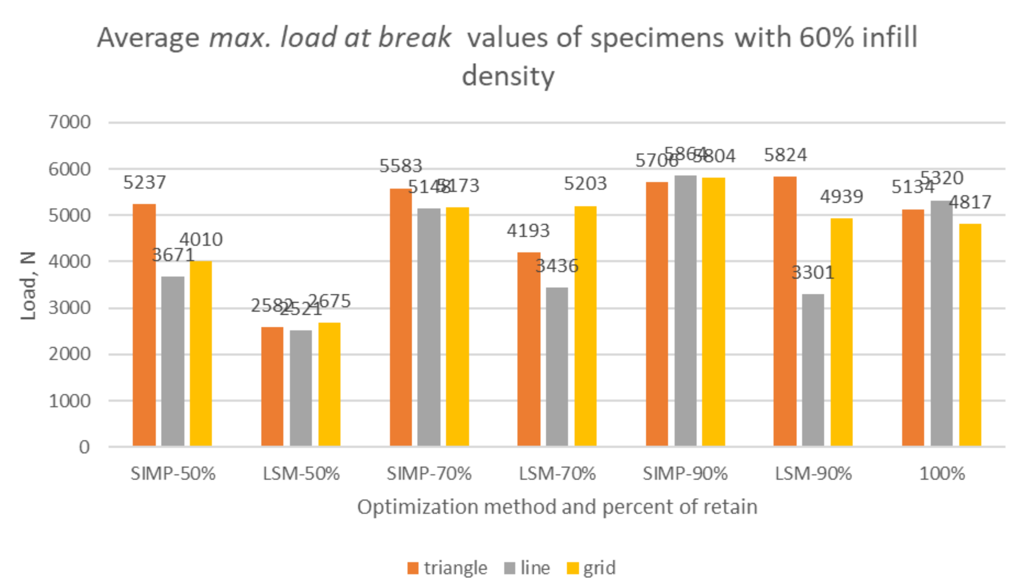
	Infill pattern:	Triangle				Line				Grid			
TO Method:	Percent of retain:	50%	70%	90%	100%	50%	70%	90%	100%	50%	70%	90%	100%
SIMP	100% infill density	1	4	7	10	13	16	19	22	25	28	31	34
		2	5	8	11	14	17	20	23	26	29	32	35
		3	6	9	12	15	18	21	24	27	30	33	36
	60% infill density	37	40	43	46	49	52	55	58	61	64	67	70
		38	41	44	47	50	53	56	59	62	65	68	71
		39	42	45	48	51	54	57	60	63	66	69	72
LSM	100% infill density	73	76	79		82	85	88		91	94	97	
		74	77	80		83	86	89		92	95	98	
		75	78	81		84	87	90		93	96	99	
	60% infill density	100	103	106		109	112	115		118	121	124	
		101	104	107		110	113	116		119	122	125	
		102	105	108		111	114	117		120	123	126	



Generally, this project consists of several significant steps as: static structural setup for selected model, topology optimization, 3d printing of setup and prototyping, obtaining load-elongation graph of products and explanation of the results. These steps of the project require the search for optimal condition, the selection of significant parameters and factors and evaluations of the results, as all steps are interdependent.

RESULTS





Top view on all tested 126 specimen

Specimens from 1 to 9

The first diagram shows the expected results as the max. load at break increases with the increase of percent of retain, while the second diagram presents the questionable results as the general trend is fluctuating with increase of percent of retain. It can be seen from the both diagrams that overall SIMP optimization results show higher results than LSM. According to this result it was noticed that topology optimization works well in compare with the density reduction that produced by Cura (60% infill density). The project requires more experiments on the models to increase the accuracy of the obtained data and it is requiring controlling the factors that may produce deviation of the results.

CONSLUSIONS & RECOMMENDATRIONS

- Total optimization time for both method is approximately one day.
- Total print time for all 126 specimen is near 22 days.
- 100% and 90% have almost same strength, while 70% and 50% of retain designs have slight lower values of max load at break.
- Tensile test results shows that specimens optimized by density method shows better results than LSM method
- There is no obviously better results among 'triangle', 'line' and 'grid' infill patterns
- The low value of density produces unexpected results and break point, that can be explained by the large gaps in the interior of the specimen

Supervisor: Didier Talamona, Associate Professor

Co-supervisor: Konstantinos Kostas, Assistant Professor

didier.talamona@nu.edu.kz , konstantinos.kostas@nu.edu.kz

School of Engineering and Digital Sciences

seds.nu.edu.kz