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Optimisation of mechanical properties of different printing mode in 3D printing

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ABSTRACT

Additive manufacturing is a layer-wise fabricating technology. There is no need for a machining process for final product because of its accurate layer fabrication to one another. This allows the user to manufacture parts directly from design software. There are many types of the additive manufacturing like selective laser sintering (SLS), fused deposition modeling (FDM), stereo lithography, polyjet printing. Materials used for a 3d printing should have a low melting point. In the polyjet printing, there are many materials like ABS, Vero Blue, Vero White, Vero Clear and so on. In this Vero Blue is the cheapest among the mainly used 3D printing materials. But we should check for its values on each way of printing types to get verified about its tensile and flexural values with regards to other materials.

Keywords: Polyjet, Object 360, Vero Blue, Tensile and Flexural properties.

INTROCUCTION

Rapid prototyping is a procedure of the producing models before the production of actual product. There are various methods of rapid prototyping. The main advantage lies in the speed of the producing physical prototypes as well as almost unlimited complexity of geometry. Additive manufacturing procedures do not require planning during the process. The materials used for rapid prototyping can differ according to the properties

and appearance like colour and glossiness. We are using vero family material i.e., Vero Blue. Polyjet printing type using a polyjet printer like the Object 360. After the design is feed into the machine, the 3D printing software changes the solid works drawing software format to the STL format which is the machine acceptance format. For every printing there are many ways of the orientation for building like XY, YX, ZX orientations [2]. From that paper we come know that the X

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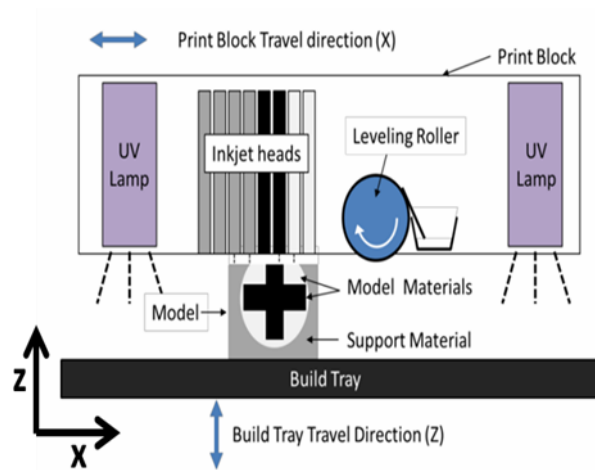


Figure 1: Build tray position

LITERATUR EREVIEW

- ASTM means the American Society of Testing and Materials. They are giving the standards for testing like minimum dimensions and the properties of the materials. Because everyone should use the same dimension properties for every materials only for the same dimensional analysis.
- In This paper the authors discussed about the build orientation for the 3D printing machine like XY, YX and ZX orientations. They have concluded that the parts build from the XY orientation would have a better tensile strength than other two.
- In This paper, Authors used five materials and they are Loctite 406, Loctite hysol 9483, vero black and Vero blue and fullcure720. The

fluctural modulus of vero blue is lower than fullcurw 720 but maximum than vero black. The tensile strength also same as like the fluctural modulus. Fullcure 720 has higher tensile strength than vero blue. Vero blue materials has higher tensile strength than vero black.

MATERIAL

Material we have selected for our project is a rigid photopolymer. Photopolymer is a In All photopolymers we have taken the Vero Blue. Vero blue combining dimensional stability and high detail visualization, this materials simulate opaque, rigid plastic. They gives the power to rapidly prototype models that closely resemble the appearance of your finished part.



Figure 2: Example for Vero Blue material

FOR TENSILE TEST

Table 1: Specimen description for tensile test

MATERIAL	ABBREVIATION
High speed matte blue	XMBT- 01, 02, 03
High quality matte blue	YMBT- 01, 02, 03
High speed glossy blue	XMGT- 01, 02, 03
High quality glossy blue	YMGT- 01, 02, 03
High speed glossy overcurring	XMGT- 04, 05, 06
High quality glossy blue overcurring	YMGT- 04, 05,06

There are two types of the printing mode and they are High Quality and High Speed.

For flexural test

Table 2: Specimen description for flexural test

MATERIAL	ABBREVIATION
High speed matte blue	XMBF- 01, 02, 03
High quality matte blue	YMBF- 01, 02, 03
High speed glossy blue	XMBF- 01, 02, 03
High quality glossy blue	YMBF- 01, 02, 03
High speed glossy overcurring	XMBF- 04, 05, 06
High quality glossy blue overcurring	YMBF- 04, 05,06

Matte appearance

Its dull or death surface, often slightly roughened and its having a lusterless surface. Matte things ore not shiny.

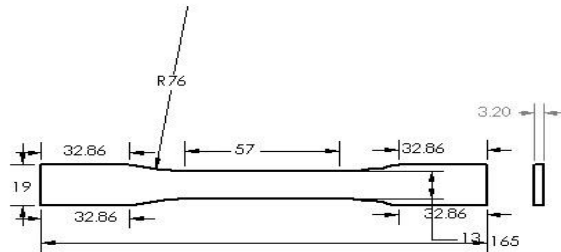
Glossy appearance

Its reflective or shiny surface and its having a surface luster or brightness, superficially attractive appearance.

Design

Design of each and every material should base on some standard dimensions. That standard

dimensions are given by the testing society. For the tensile and flexural test, the dimensions are given by the ASTM (American Society for Testing Materials)[1]. Each test has a definite shape of the testing material. For the tensile test the material should be in Dog bone shape. The maximum length of the tensile test specimen is the 165mm. For the flexural test the material should be in the rectangular shape and the dimension is the 125mm. The design dimensions are taken from the ASTM standards.



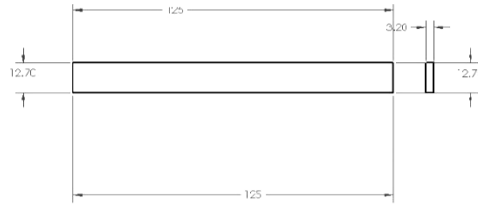


Figure 3: 2D model for tensile and flexural test

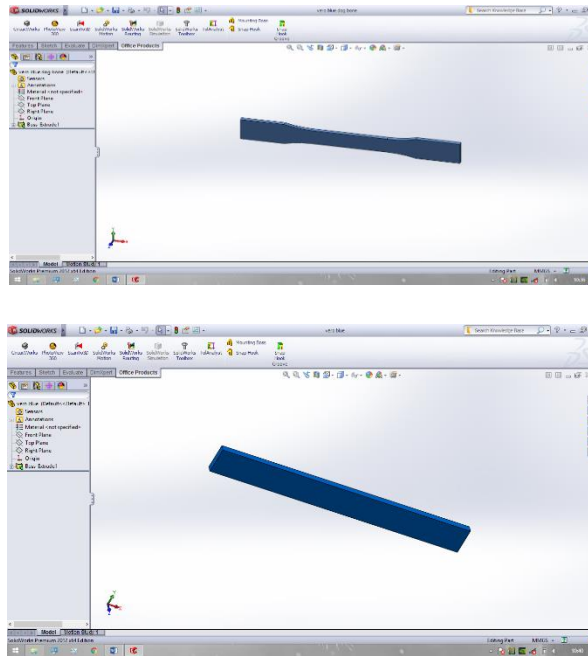


Figure 4: 3D model developed from solid works

Testing procedure

Basically the matte and glossy materials have the same material dimensions but their dimensions change according to the test which we have taken. Their dimensions are taken from the ASTM standard. But the ASTM standard have different variety for dimensioning but we have taken the Type 1 dimensions from 5 types of the dimensions. They should designed as a 2D model and designed as a 3D model from the designed software. We have used Solidworks software for designing 3D model.

After designing the 3D model, feed the design into 3D printing software by the converting modeling format into 3D printing format i.e., .STL format. After feeding the software from computer to the polyjet machine, the software automatically changes into .STL format. We have taken 3

specimen for every type of printing mode and for every finish. For tensile test two finishes are available and two printing modes are there.

For tensile test, the combination of the materials is High speed matte finish and High speed glossy finish printing mode. And High quality matte finish, High quality glossy finish printing modes are taken for our testing.

Build orientation of the specimen should select to get a efficient and cheapest build of the specimen. From the literature review [1]. The XY, YX and ZX orientation figures are mentioned in the figure 4. From the literature review we have selected the XY orientation.

After completion of all preprinting work the Object 360 printer is set to run printing. Before printing the printer should warm up for 10 minutes. After warm up the light glows, that indicate the printer start to run. Then the printer prints the

material one by one. We have set to print 6 specimen for every printing mode respective to the every finish type. After printing the material should clean for 10 minutes and the specimens are named according to the printing mode and finish of the materials mention in the table 4.

After the naming, the specimen is set for testing. For tensile test the testing machine is the UTM (universal testing machine) under 10 KN machine because of the tensile strength of the specimens. The specimens are tested and the graphs are plotted for tensile and flexural specimen.

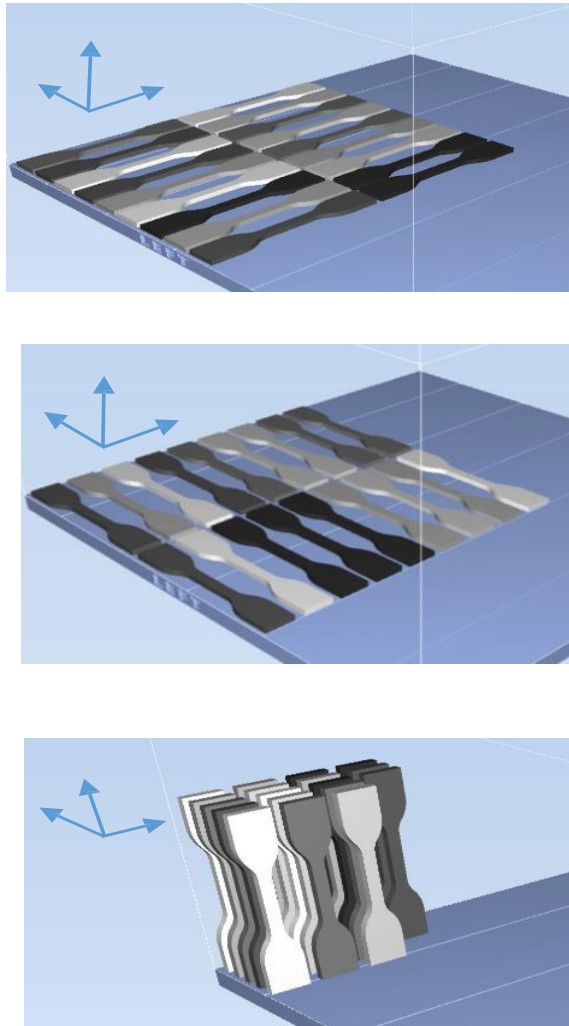


Figure 4 : Build orientation

The values from graph are mentioned below For tensile test

No	S.ID	σ_{LOW} MPa	σ_{high} MPa	E_t MPa
1	XGBT01	0.895	3.083	1100
2	XGBT02	0.565	1.937	705
3	XGBT03	0.758	2.345	803

4	YGBT04	0.704	2.498	912
5	YGBT05	0.702	2.236	777
6	YGBT06	0.714	2.437	880
7	XGBT04	0.949	3.215	1100
8	XGBT05	0.749	2.473	888
9	XGBT06	0.808	2.756	995
10	YGBT01	0.578	2.177	829
11	YGBT02	0.701	2.154	729
12	YGBT03	0.535	1.817	633
13	YMBT01	0.613	2.169	812
14	YMBT02	0.578	1.964	719
15	YMBT03	0.545	2.021	764
16	XMBT01	0.791	2.471	886
17	XMBT02	0.747	2.114	681
18	XMBT03	0.755	2.044	650

And for the flexural test, the values are obtained form are mentioned below

S.ID	EH MPa	SM MPa	WB/V Kj/m2
XMBF01	869	19.1	106.699
XMBF02	1050	21.3	111.220
XMBF03	892	20.3	113.721
YGBF04	1080	29.6	159.460
YGBF05	1340	34.6	182.190
YGBF06	1360	33.5	167.049
XGBF01	1050	25.2	131.518
XGBF02	933	23.9	133.357
XGBF03	1000	23.0	105.027
XGBF04	1350	36.9	199.639
XGBF05	1420	37.0	175.422
XGBF06	1320	36.8	180.732
YGBF02	1110	27.1	134.215
YGBF01	892	25.4	134.133
YGBF03	967	25.0	122.875
YMBF01	973	24.3	118.184

YMBF02	592	21.3	124.059
YMBF03	704	18.6	114.372

RESULT

From the table we can conclude that the average value of the tensile modulus of the XGBT over curing series have the higher tensile modulus. XMBT series have the lowest tensile modulus.

The complete order for the tensile modulus will be like XGBT over curing higher than XGBT higher than YGBT over curing higher than YMBT higher than YGBT higher than XMBT series. Finally the High Quality over curing series have the

better tensile modulus as compared to the other five series.

For the flexural, the flexural modulus of the XGBF over curing series has the higher values. Lowest values are obtained from the XMBF series.

The complete order for the flexural modulus will be in the order, XGBF over curing series higher than YGBF over curing series higher than XGBF series higher than YGBF series higher than YMBF series higher than XMBF series.

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