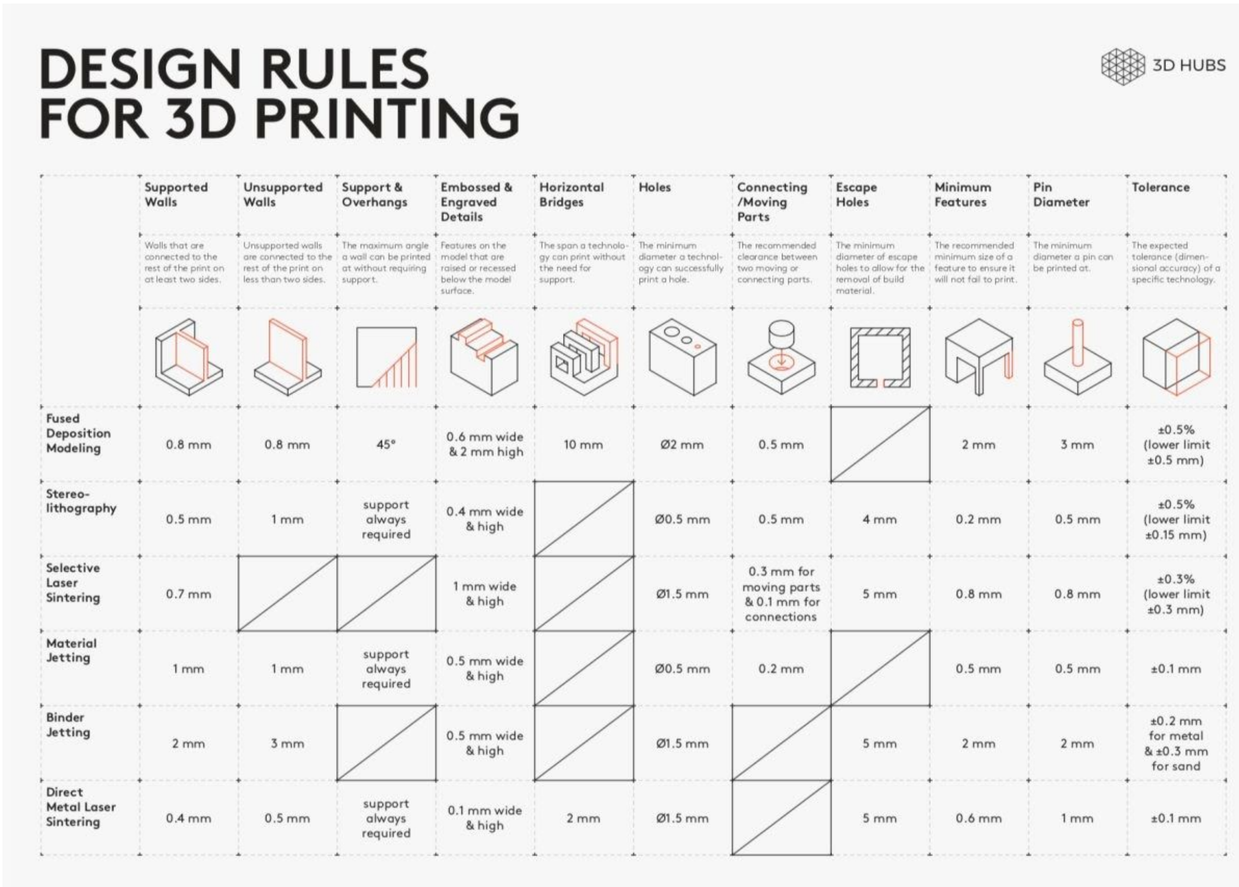
Additive manufacturing_Printability:
Source:
https://www.3dhubs.com/knowledge-base/how-design-parts-fdm-3d-printing/#introduction



	Supported Walls	Unsupported Walls	Support & Overhangs	Embossed & Engraved Details	Horizontal Bridges	Holes	Connecting /Moving Parts	Escape Holes	Minimum Features	Pin Diameter	Tolerance
	Walls that are connected to the rest of the print on at least two sides.	Unsupported walls are connected to the rest of the print on less than two sides.	The maximum angle a wall can be printed at without requiring support.	Features on the model that are raised or recessed below the model surface.	The span a technology can print without the need for support.	The minimum diameter a technology can successfully print a hole.	The recommended clearance between two moving or connecting parts.	The minimum diameter of escape holes to allow for the removal of build material.	The recommended minimum size of a feature to ensure it will not fail to print.	The minimum diameter a pin can be printed at.	The expected tolerance (dimensional accuracy) of a specific technology.
Fused Deposition Modeling	0.8 mm	0.8 mm	45°	0.6 mm wide & 2 mm high	10 mm	Ø2 mm	0.5 mm		2 mm	3 mm	±0.5% (lower limit ±0.5 mm)
Stereo-lithography	0.5 mm	1 mm	support always required	0.4 mm wide & high		Ø0.5 mm	0.5 mm	4 mm	0.2 mm	0.5 mm	±0.5% (lower limit ±0.15 mm)
Selective Laser Sintering	0.7 mm			1 mm wide & high		Ø1.5 mm	0.3 mm for moving parts & 0.1 mm for connections	5 mm	0.8 mm	0.8 mm	±0.3% (lower limit ±0.3 mm)
Material Jetting	1 mm	1 mm	support always required	0.5 mm wide & high		Ø0.5 mm	0.2 mm		0.5 mm	0.5 mm	±0.1 mm
Binder Jetting	2 mm	3 mm		0.5 mm wide & high		Ø1.5 mm		5 mm	2 mm	2 mm	±0.2 mm for metal & ±0.3 mm for sand
Direct Metal Laser Sintering	0.4 mm	0.5 mm	support always required	0.1 mm wide & high	2 mm	Ø1.5 mm		5 mm	0.6 mm	1 mm	±0.1 mm

Material to be used : Polypropylene (PPE) pellets

FDM printing (Fused deposition Modelling_based on Material extrusion**)**

- **Layer** Thickness and bonding plays a major role. A 3D printed part purely exhibits anisotropic behaviour. Meaning they are stronger in the direction of the grains (in our case the layer lengths)
- **Support** Avoid overhangs in your design when possible, by using angles smaller than 45 deg. *YHT rule (Y- works as it branches at 45 deg, while H works if the bridging horizontal element is less than 20 mm but a T would need supports for its branches)*

  Advantage - helps printing complex geometries

  Disadvantage - supports need to be removed from the printed part which may lead to uneven surface finishes.
- **Infill** is used to save costs and material in printing processes. Increasing infill percentage makes the geometry stronger. If strength is not necessary for a certain part the percentage of infill can be decreased.

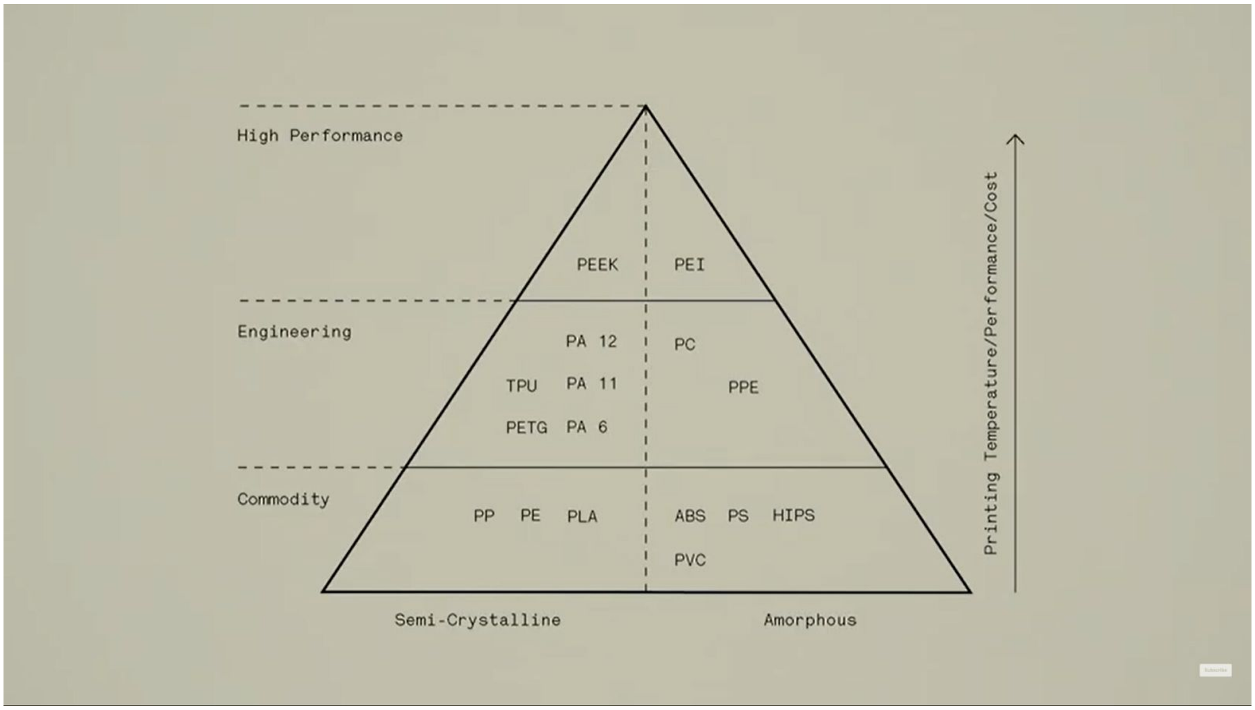


Diagram showing the materials in the order of high performance and cost

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Rules of Thumb

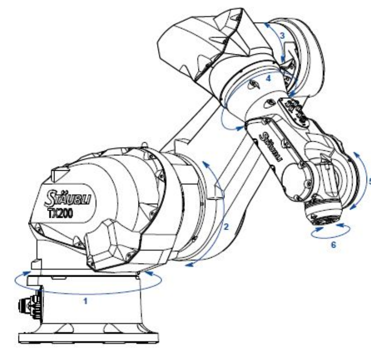
- If a bridge exceeds 5mm, sagging or marks from support material can occur. Splitting the design or post-processing can eliminate this issue.
- For critical vertical hole diameters, drilling after printing is recommended if high accuracy is desirable.
- The addition of support will allow FDM printers to print wall angles greater than 45 degrees.
- Include a 45 degree chamfer or radius on all edges of an FDM part touching the build plate.
- For applications with small vertical pins, add a small fillet at the base or consider inserting an off the shelf pin into a printed hole instead.
- Splitting a model, re-orientating holes, and specifying build direction are all factors that can lower cost, speed up the printing process, and improve the strength and print quality of a design.

Robot Specs:
Staubli tx-200 - The TX200 range has a payload of up to 150 kg with a maximum reach of 2594 mm.
https://www.staubli.com/en/robotics/product-range/industrial-robots/6-axis-robots/tx200/

MODEL	TX200	TX200L
Maximum load	130 kg, 286.6 lb (150 kg, 330 lb under conditions)	80 kg, 176.4 lb (100 kg, 220 lb under conditions)
Nominal load	100 kg, 220 lb	60 kg, 132.2 lb
Reach d'action (between axis 1 and 6)	2194 mm, 86.3 in	2594 mm, 102.1 in
Number of degrees of freedom	6	6
Repeatability – ISO 9283	± 0.06 mm	± 0.1 mm
Stäubli series controller	CS8C HP	CS8C HP
Weight	980 kg, 2160 lb	1000 kg, 2204 lb

MAXIMUM SPEED		
Axis 1	160°/s	160°/s
Axis 2	160°/s	160°/s
Axis 3	160°/s	160°/s
Axis 4	260°/s	260°/s
Axis 5	260°/s	260°/s
Axis 6	400°/s	400°/s
Maximum speed at load gravity center	12 m/s	14 m/s
Maximum inertia axis 5	45 kg.m^2	40 kg.m^2
Maximum intertia Axis 6	20 kg.m^2	15 kg.m^2
Brakes	All axes	

Motion range



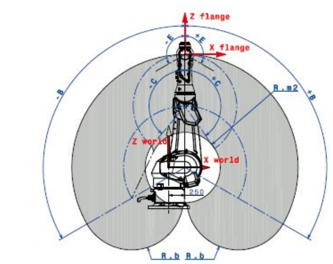
WORK ENVELOPPE		
Maximum reach between axis 1 and 5 (R.M)	2000 mm, 78.74 in	2400 mm, 94.49 in
Maximum reach between axis 2 and 5 (R.M)	1750 mm, 68.90 in	2150 mm, 84.65 in
Minimum reach between axis 1 and 5 (R.m1)	365 mm, 14.37 in	528 mm 20.79 in
Minimum reach between axis 2 and 5 (R.m2)	545 mm, 21.47 in	690 mm, 27.17 in
Minimum reach between axis 3 and 5 (R.b)	800 mm, 31.50 in	1200 mm, 47.24 in

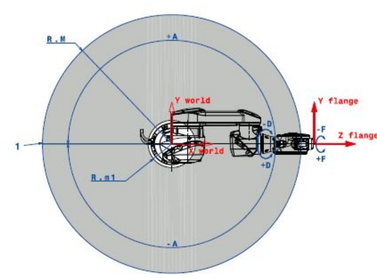
RANGE OF MOTION		
Axis 1 (A)	± 180°	± 180°
Axis 2 (B)	+ 120°/-115°	+ 120°/-115°
Axis 3 (C)	+145°/-140°	+145°/-140°
Axis 4 (D)	± 270°	± 270°
Axis 5 (E)	± 120°	± 120°
Axis 6 (F)	± 270° (1)	± 270° (1)

INSTALLATION ENVIRONNEMENT	
Working temperature according to NF EN 60 204-1	+5°C to +40°C, +41°F to +104°F
Humidity according to standard directive NF EN 60 204-1	30% to 95% max. non-condensing
Attachment methods	Floor/Ceiling
Vertical cable outlet version	•
Pressurized version	•

FOREARM CONNECTIONS		
Pneumatic		2 solenoid valves in option 5/2-way monostable (compressed air) 3 direct lines between the base and the forearm
Electrical	Standard	1 female 19-contact socket (7 twisted pairs including 2 shielded, 3 power contacts)
	Ethernet option	A 19-contact female cylindrical connector with 5 twisted pairs and 3 power contacts + 4-contact female cylindrical connector M12 code D for a Cat 5e Ethernet link.
Cleanroom standard ISO 14644-1		5
Protection class according to EN 60529		IP65 / IP67

Work envelope





Martian concrete:
Constitutes of 240 deg of 50% molten sulphur and 50% martian soil aggregates 1mm
Compressive strength in excess of 50 MPa.

In conclusion, the developed sulfur based Martian Concrete is feasible for construction on Mars for its easy handling, fast curing, high strength, recyclability, and adaptability in dry and cold environments. Sulfur is abundant on Martian surface and Martian regolith simulant is found to have a well graded particle size distribution to ensure high strength mix. Both the atmospheric pressure and temperature range on Mars are adequate for hosting sulfur concrete structures. Based upon the experimental and numerical results presented in this paper, the following conclusions can be drawn:

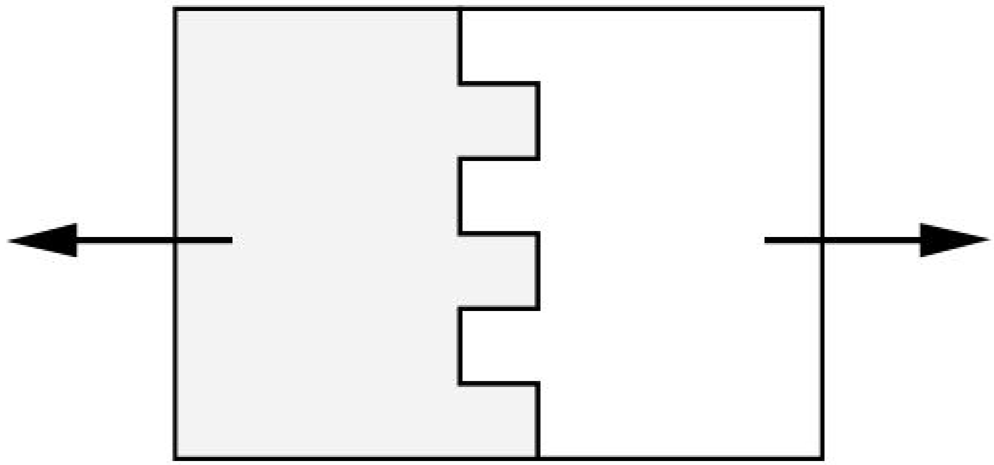
1. The best mix for producing Martian Concrete (MC) is 50% sulfur and 50% Martian soil simulant with a maximum aggregate size of 1 mm. The developed MC can reach compressive strength higher than 50 MPa.
2. The optimum particle size distribution (PSD) of Martian regolith simulant is found to play a role in achieving high strength MC compared to sulfur concrete with regular sand.
3. The rich metal elements in Martian soil simulant are found to be reactive with sulfur during hot mixing, possibly forming sulfates and polysulfates, which further increases the MC strength.
4. Simultaneously, the particle size distribution of aggregate is shifted to lower ends, resulting in less voids and higher performance of the final mix.
5. With the advantage of recyclability, recast of MC can further increase the material's overall performance.
6. Applying pressure during casting can also increase the final strength of MC. Sulfur shrinks when it is cooling down. By reducing the mixture's volume during casting, the number and the size of cavities of the final product are decreased.
7. Although developed for conventional cementitious concrete, the Lattice Discrete Particle Model (LDPM) also shows excellent ability in simulating the mechanical behavior of MC under various loading conditions.

Designing for interlocking joints

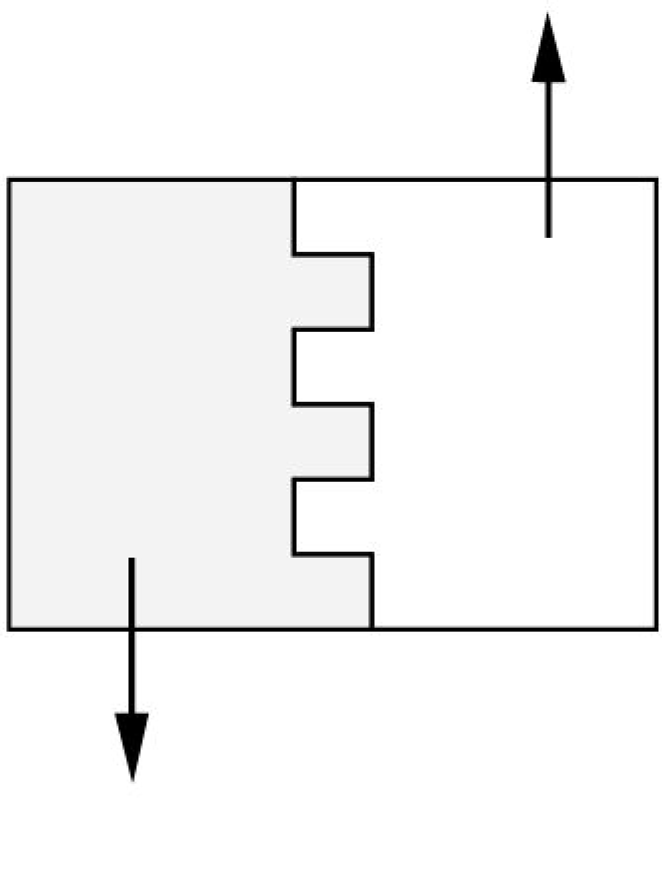
There are 3 forces to consider when designing interlocking joints:

- Friction - the critical force that holds the joint together. The tighter the joint is, the higher the friction and the more difficult it will be to pull apart

- Tension - the force that acts to pull the joint apart



- Shear - the force perpendicular to tension that pulls the joint sideways (a tearing force)

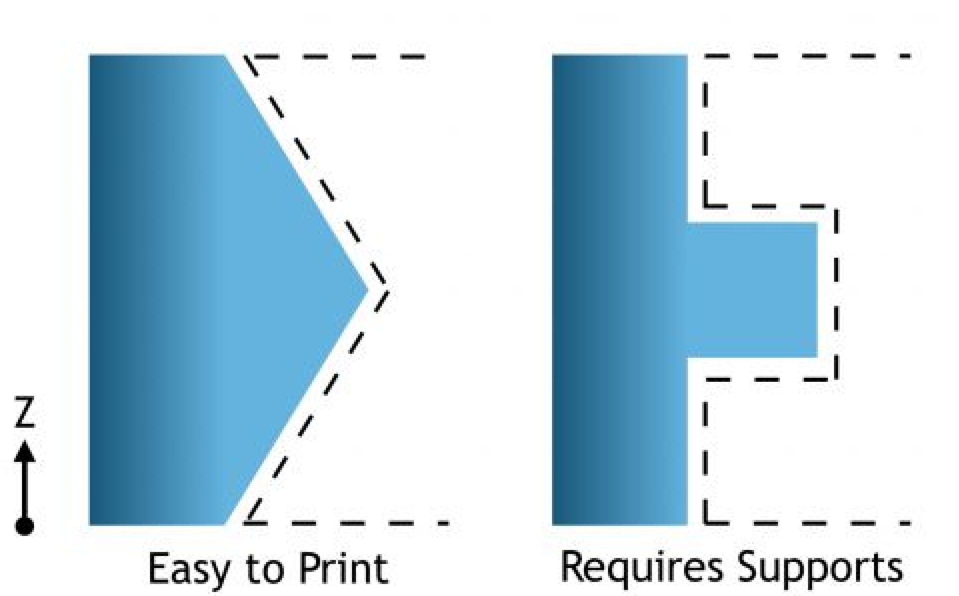


Dovetails

A classic dovetail joint

When it comes to constraining two parts, many people think in right angles. And this is efficient, especially when thinking about machining; right angles are generally much easier and faster to make than odd angles, requiring fewer setups and no special bits or indexing tables. To a 3D printer, however, dovetails and straight walls are all the same. With no extra effort, you can constrain another degree of freedom. This comes in handy everywhere, whether you want a sliding assembly or a fastener-less T-joint.

Exploring even further, angled geometry in general can help in 3D printing. For instance, printing a sideways V profile, shown below on the left, can create a constraint that would be difficult to machine, but is trivial to print. Meanwhile, a classic tongue and groove joint, as shown on the right, is hard for most printers to make because of the overhang it creates. This overhang results in a poorly supported bottom face with bad dimensional accuracy, and should be avoided if possible.



Profiles of a sideways V wall (left) and a tongue-and-groove joint (right)

A dovetail connection is a type of interlocking connection that is very stable yet easily removable. Taking its name from the shape of the connectors, a dovetail connection is similar to what you would find in jigsaw puzzles. They aren't exactly the most versatile since they are best used on flat and thin objects.

A dovetail connection provides a lot of contact between the two parts that it is joining. The resulting increase in friction makes dovetail connections very hard to break. In fact, dovetail connections are virtually impossible to separate by tension forces. The increased contact area is also great for applying adhesives.

3D printing with Silicone for insulation:

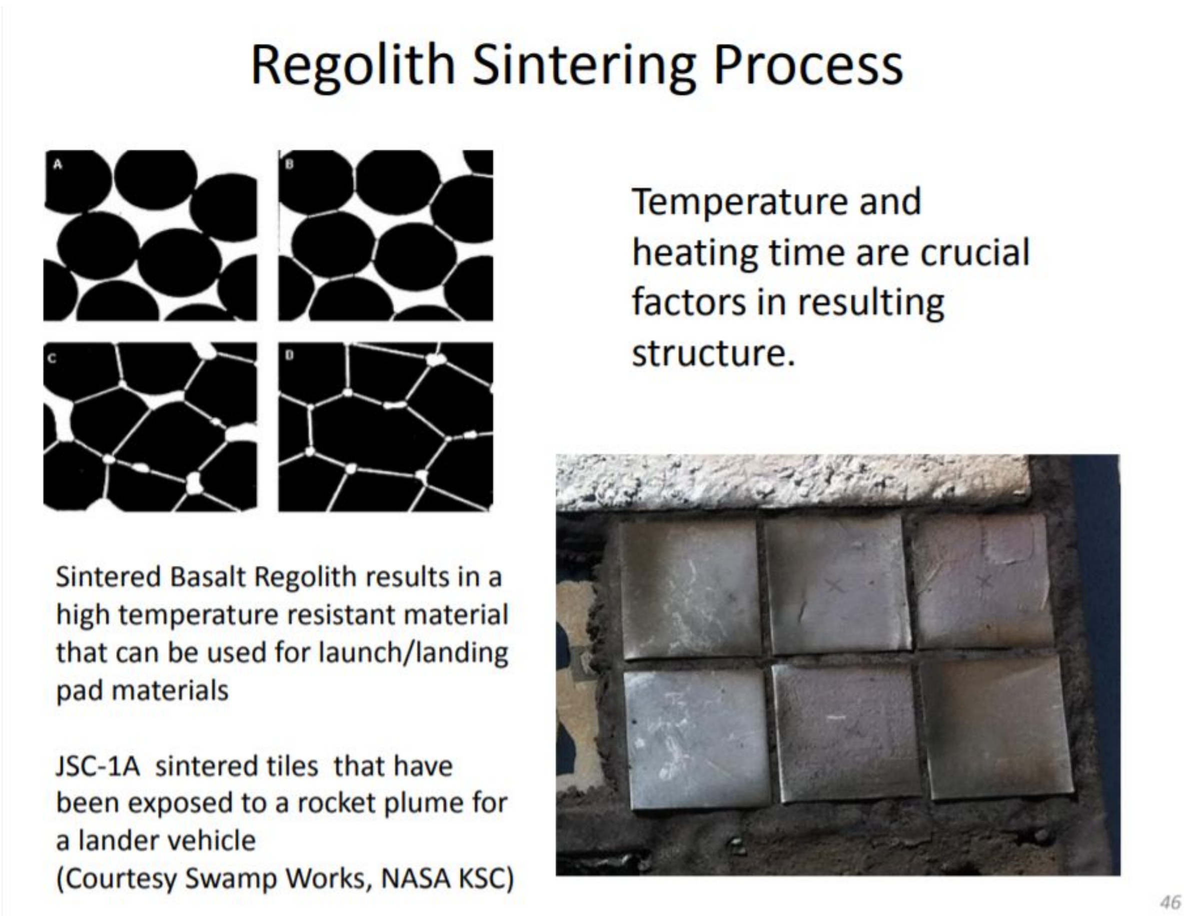
https://all3dp.com/2/silicone-3d-printer-all-you-need-to-know/

https://3dprinting.com/3d-printing-use-cases/an-overview-of-silicone-3d-printing/

https://all3dp.com/2/silicone-3d-printer-all-you-need-to-know/

Sintering of Regolith:

Regolith Sintering: Sintering is the bonding of particles below the melting temperature, causing particles to cross grain boundaries by means of temperature and pressure. Sintering of the lunar regolith has been discussed at some length [12] as a method for producing construction materials from in situ resources at a lunar base.



https://www.youtube.com/watch?v=jVCiPTXYYu8
https://www.youtube.com/watch?v=fzBRYsiyxjI