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Robotic Fast Repair of Defects in Asphalt Roads

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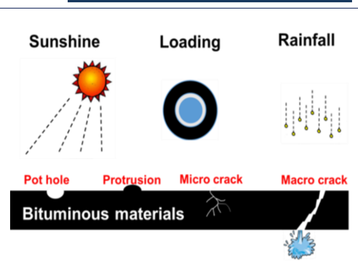
Problem

- Asphalts, the most common road paving material, do get degraded.



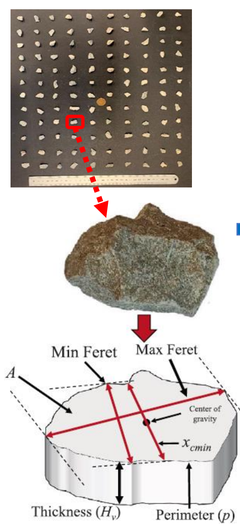
- Current repairs methods are largely manual.

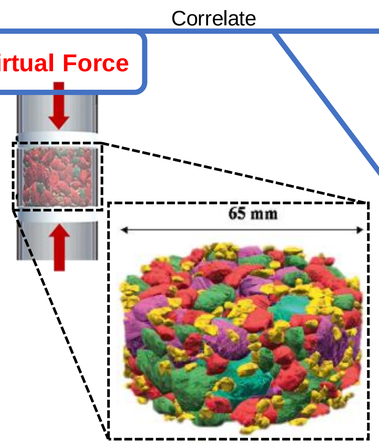
Motivation

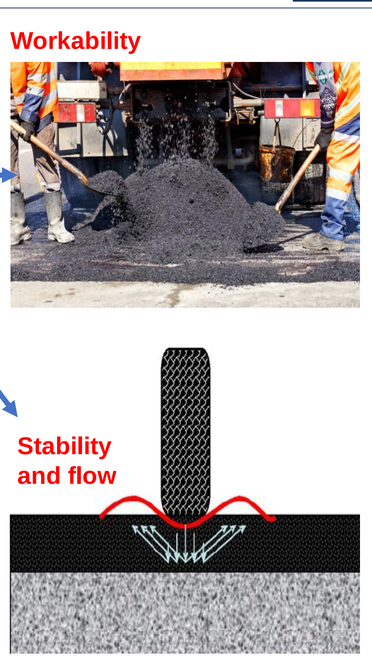
Manual road repair techniques expose work gangs to road accidents. Moreover, they generate wastes, and their quality could be inconsistent. Application of advanced technologies such are 3D printing and physics engines could be an excellent opportunity to automate the repair works. With 3D printing, robots could precisely follow and repair complex defect geometries. A robotic repair will mean reduced human interventions and errors; and, this will have a tremendous impact on the future of road maintenance.

Approach

Computational design of asphalt mixtures using physics engine

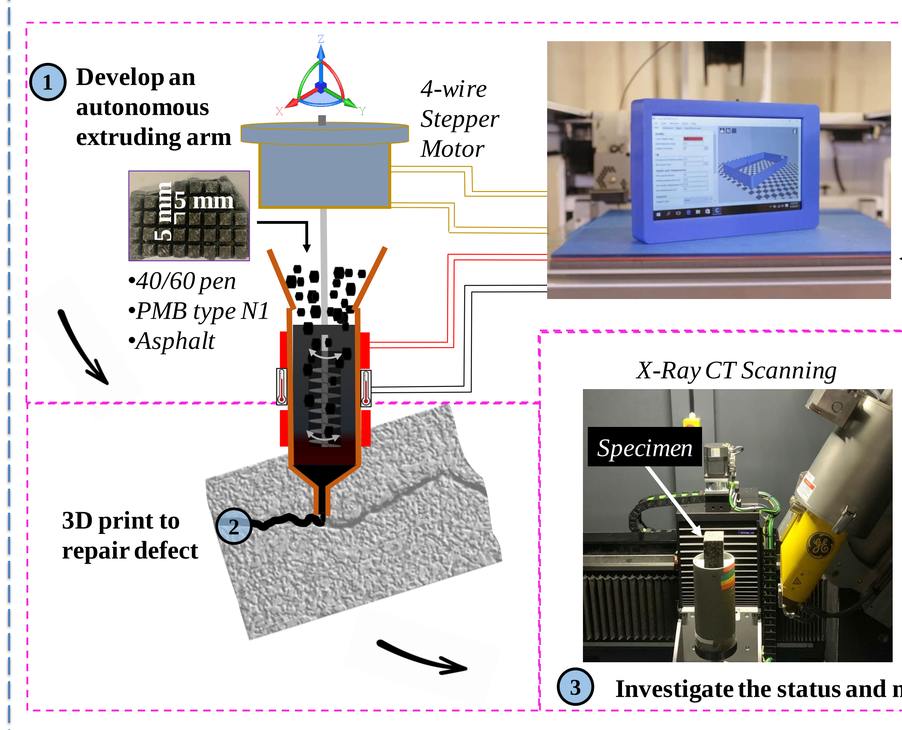




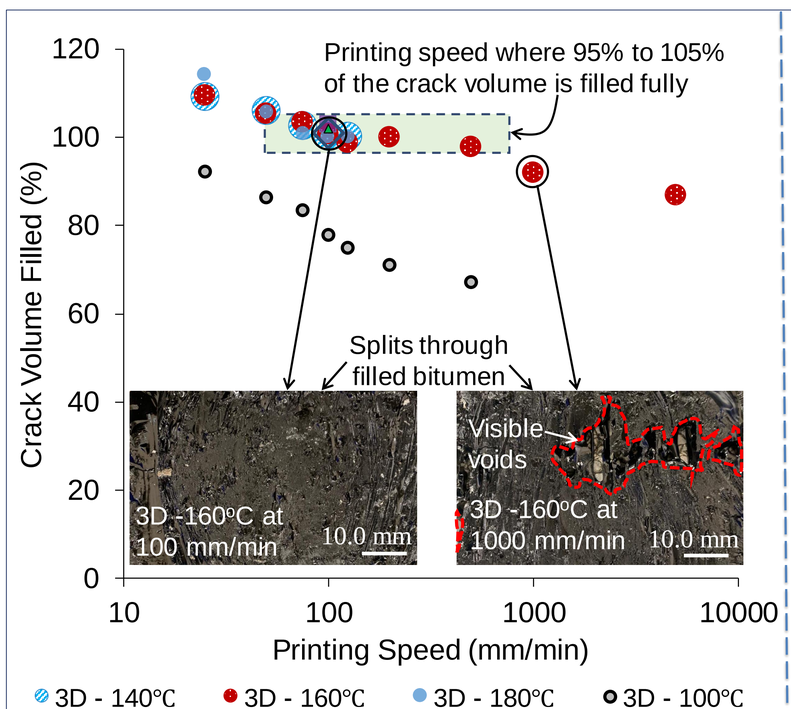


1. Aggregate morphology and gradation
2. Generate virtual asphalt
3. Balance between mixture workability and performance

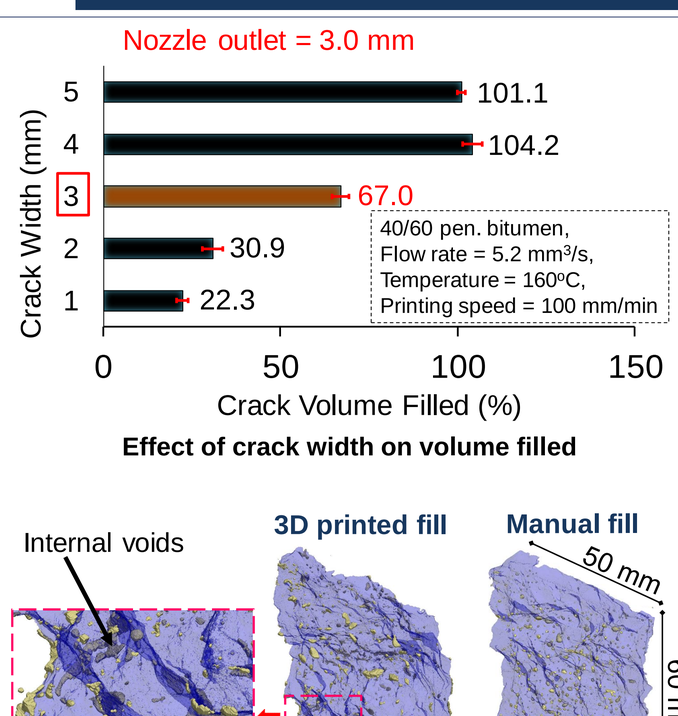
Experimental phase



Results and Conclusions



Effect of extrusion temperature and printing speed on crack volume filled



Effect of crack width on volume filled

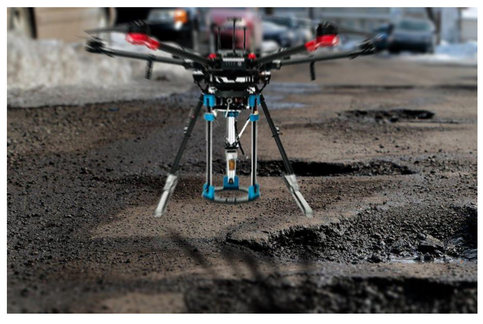
Voids in filled cracks showing discontinuity

What we know so far:

1. It is feasible to automate the repair of asphalt concrete defects such as cracks using 3D printing technology.
2. Extrusion temperature and printing speed influences the volume and quality of crack fills.
3. For efficient filling, the nozzle diameter of extruders must be dynamically adapted to the width of cracks.
4. 3D printed fills contained higher air voids. However, the voids were not connected and could prevent water ingress.

Next Step

1. Complete optimising the 3D printing operational parameters for asphalt concretes.
2. Demonstrate autonomous crack and pothole repair on site with unmanned vehicles.



Reference

A. Garcia-Hernandez, L. Wan, S. Dopazo-Hilario, A. Chiarelli, and A. Dawson, "Generation of virtual asphalt concrete in a physics engine," *Constr. Build. Mater.*, vol. 286, p. 122972, 2021.

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