

3D printed thermoplastic composite diffusers for culvert rehabilitation

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Introduction

- Deteriorating and failing culverts across the country has prompted highway engineers to seek various solutions to replace or rehabilitate the culverts.
- Slip-lining culvert outlets with performance-enhancing diffusers that have a hydraulically optimized geometry can extend the useful life of culverts, without reducing the culvert capacity.
- Each culvert diffuser has a different hydraulic and hence a different geometric design.
- Large scale 3D printing technology enables manufacturing of the optimized diffusers with individualized at considerably lower prices compared to other methods currently available.

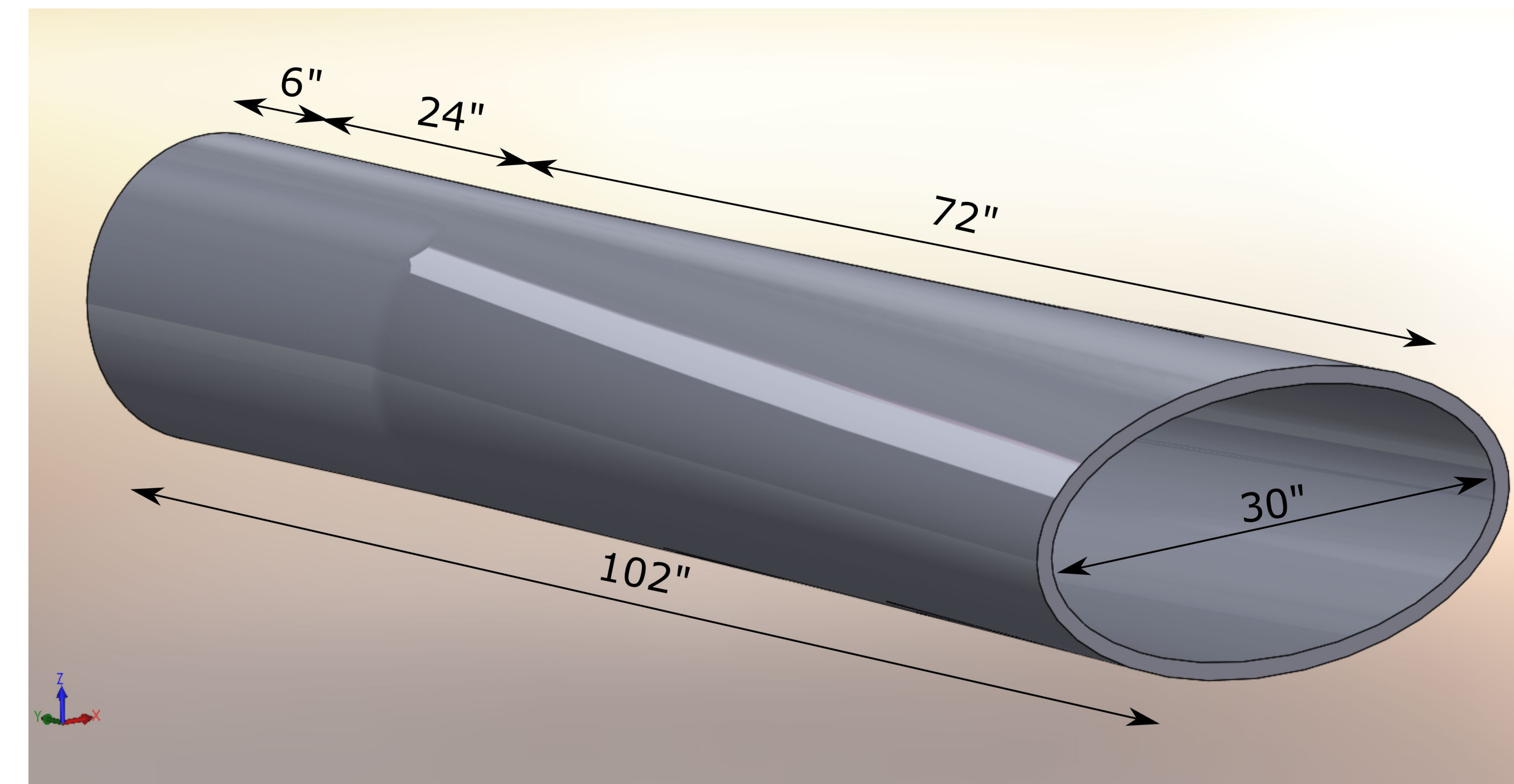


Fig: 3D model of the diffuser to be tested at Thorndike, ME culvert site.

Methods

- The designs for optimized culvert diffuser designed for Thorndike, Maine were used for this study.
- The designed culvert was 1 inch thick and 102-inch-long. The diameter at the inlet end was 15 inch and the major diameter at the outlet end was 30 inches.
- PLA/wood material was used for this study.
- Diffuser was designed to replace the existing fiberglass diffuser section.
- A finite element analysis was carried out to verify whether the designed section can withstand the backfill loads and avoid buckling.
- Segmental construction was adopted to enable manufacturing of diffusers longer than build envelope of the 3D printer.

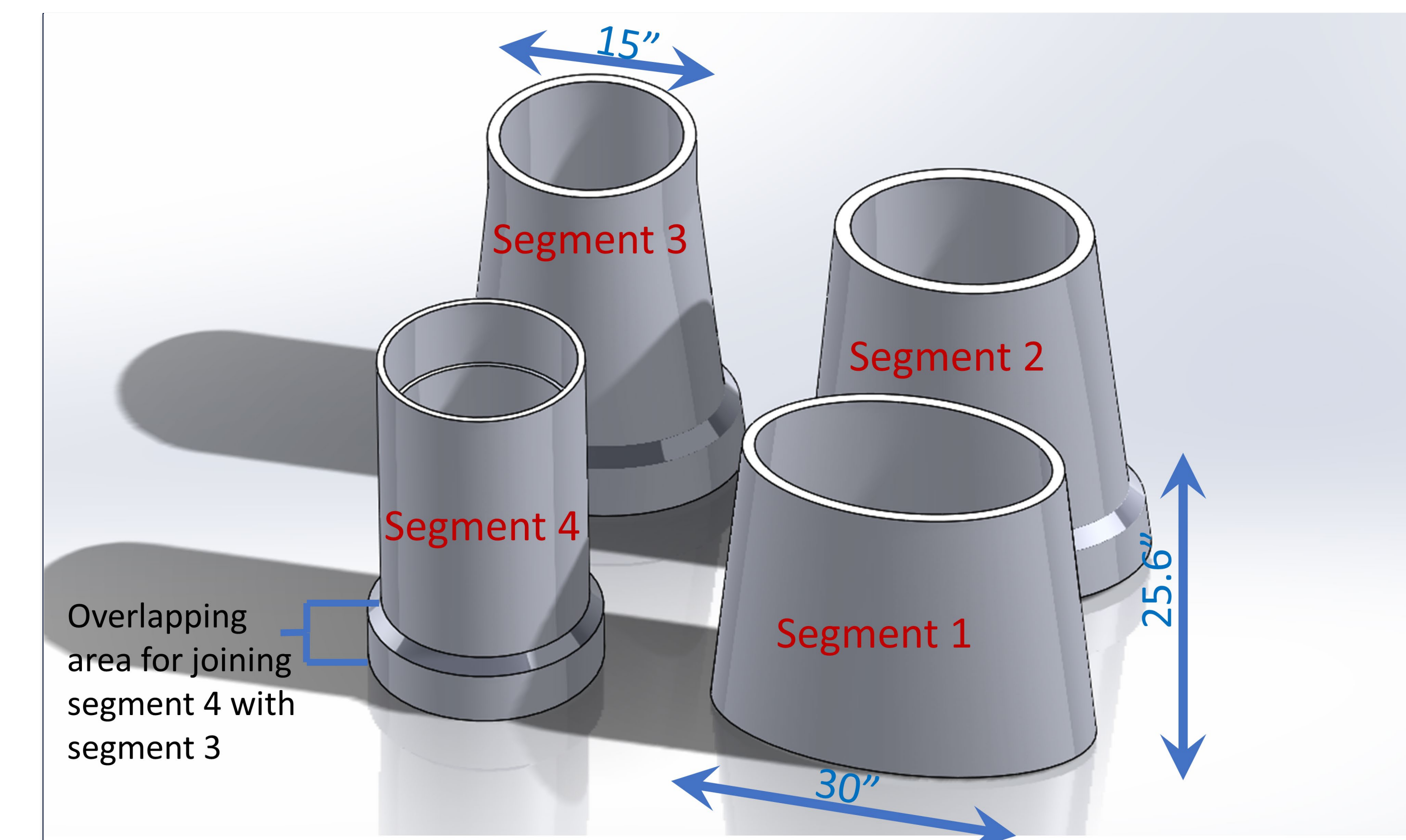


Fig: Four segments of diffuser for 3D printing.

Results and future work

- The four segments of the diffuser are expected to be printed in the last week of September.
- The segments will be joined using Pliogrip 7770 urethane adhesive.
- The estimated cost for the manufacturing the diffuser was \$2,500 whereas the manufactured cost for the fiberglass diffuser was \$15,000.
- The diffuser will be slip-lined with the existing culvert at the site in early October.
- Monitoring the performance of the segmentally printed optimized diffuser would allow us to design bigger and more efficient culvert diffusers in the future.



Fig: Fiberglass culvert diffusers. (courtesy-Alexandar Mann, PE, MaineDOT)