Cont(Knit)uous Rubble

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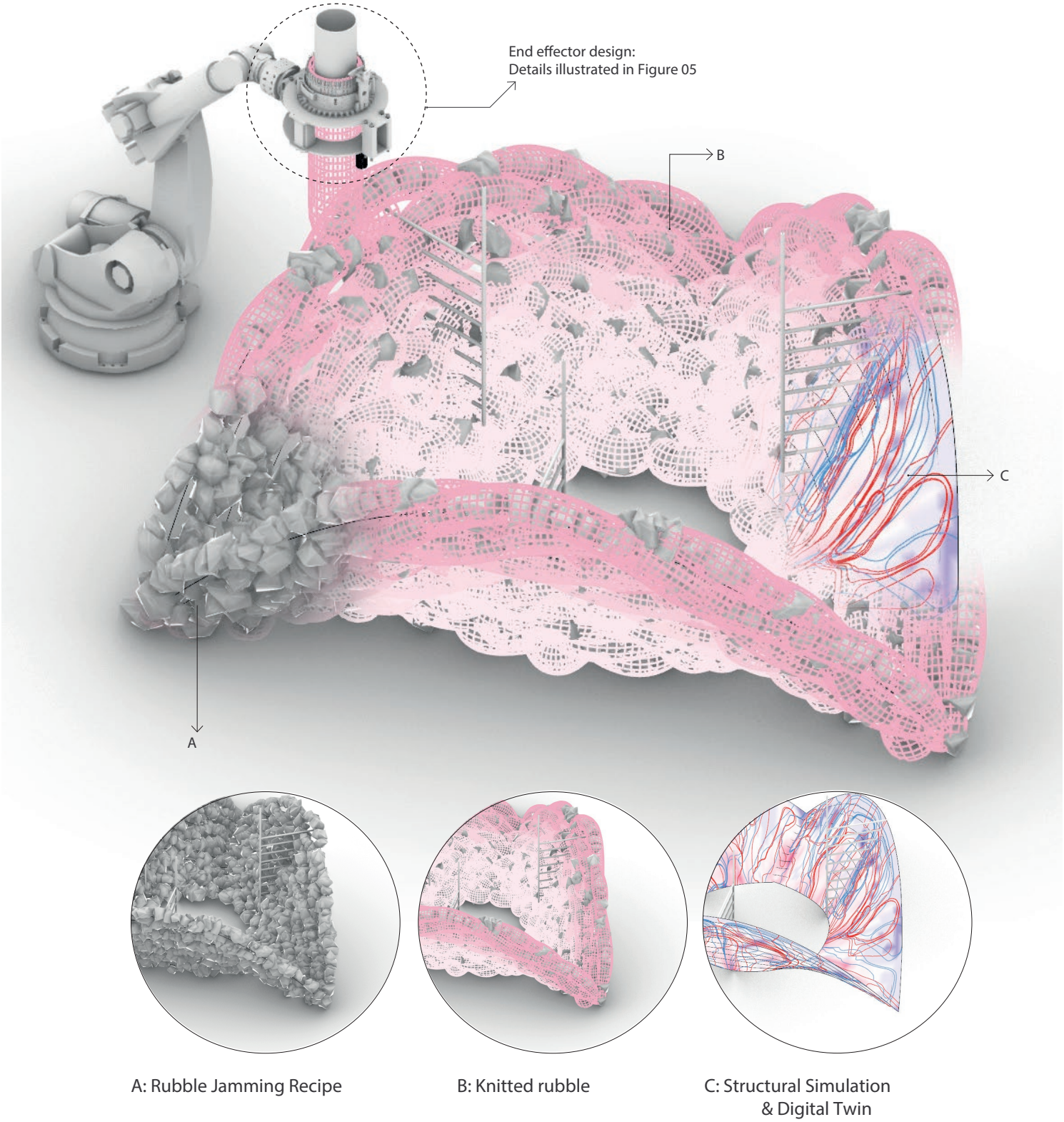

Figure 01: Automated Fabrication System overview

Project Description:

Con(knit)tuous Rubble addresses the energy-intensive processing and downcycling of concrete demolition waste by developing a soft container and jammed unprocessed rubble automated fabrication system(fig.1)

Concrete comprises about half of the construction material market and demolition waste volume. As more buildings undergo partial or full demolition, concrete rubble stock will increase. Current reuse methods either downcycle the material into backfilling and road construction, or require intensive sorting, transporting, and crushing into 8-16 mm aggregates with the addition of portland cement for recycled concrete (fig.2). Academic research often focuses on uniformly sized rubble, while larger pieces (>400 mm) require complex carving and scanning, or mortarbased assembly.

Our project works with irregular rubble up to 300 mm wide (fig.3), avoiding computationally intensive robotic placement. We use a knitted and wrapped container constructed in real-time, where rubble is poured sequentially and compacted through percussion and material tension (fig.4). The system is analogous to 3D printing, where the toolpath, rubble locking, and container flexibility must be tuned to enable overhangs, bridging, and layer adhesion.

The research involves two integrated systems: a material system, tackling the fine-tuning of the jammed rubble recipe and the container (fig.5); and a fabrication system, comprising a custom end-effector. In the rubble recipe, density is used as an approximation for concrete quality. A global structural analysis and rough pre-sorting using sifting and machine vision helps us determine the density distribution for larger rubble (>150mm), as well as the amount of granular rubble (<150mm) required for jamming each segment. The container parameters include the knitting and wrapping speed, affecting the tensile strength of the system, synchronously to rubble jamming. The end-effector tool integrates a knitting machine, a wrapping unit, and a percussion-tumbling mechanism that compacts each 500mm container-rubble segment (fig.6)

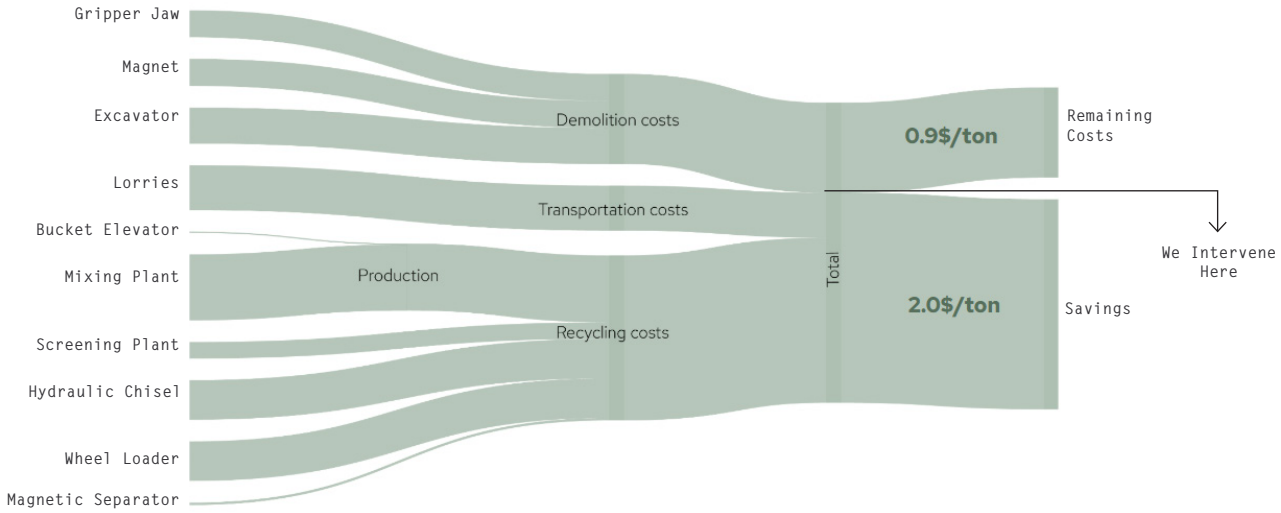

Figure 02: Cost of the Current Rubble-reuse process

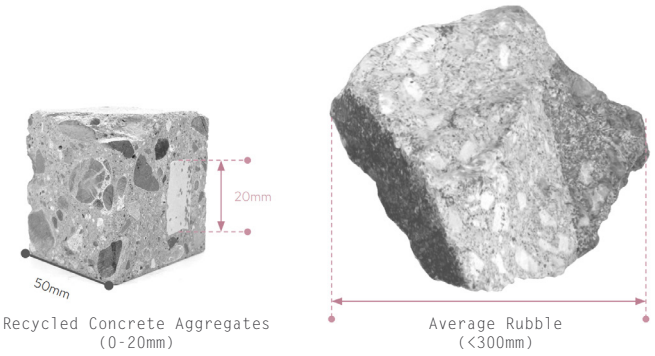

Figure 03: Recycled Concrete Aggregate vs. Rubble

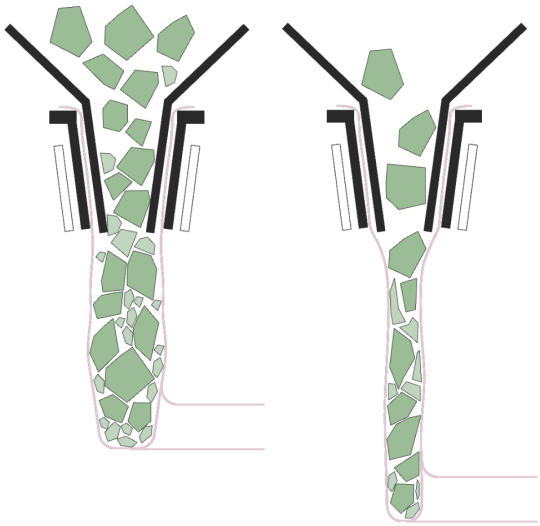

Figure 04: Real-time Pouring and Knitting

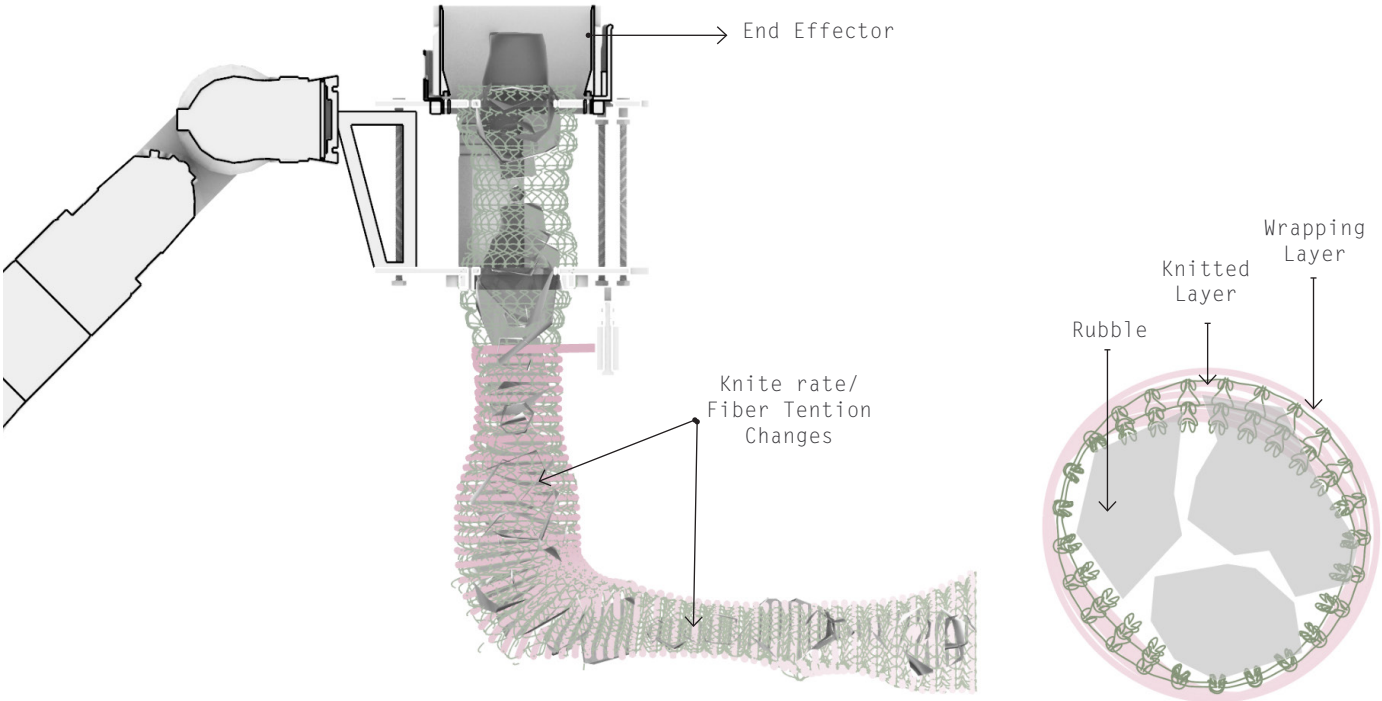

Figure 05: knit rate, fiber tension, material changes

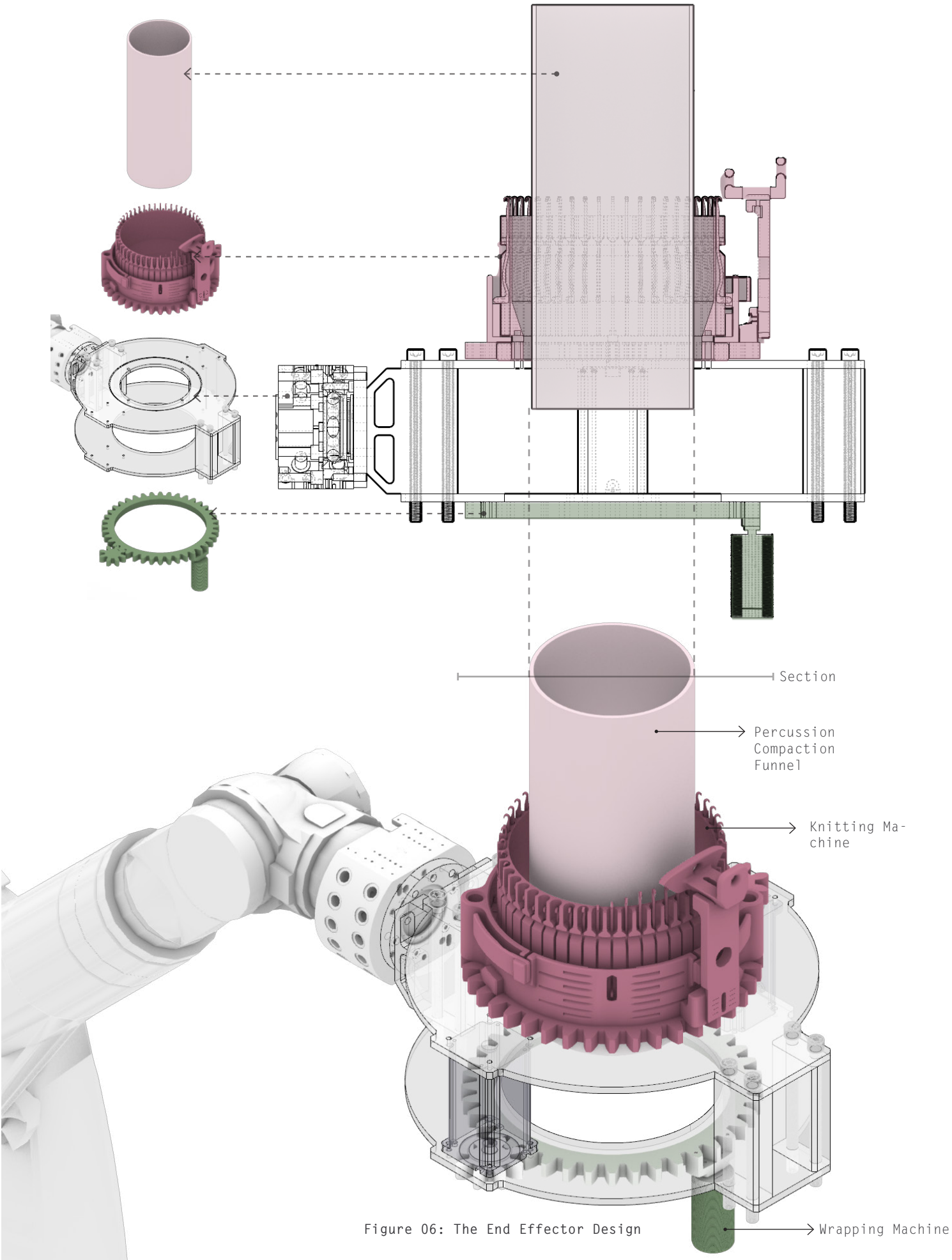

Figure 06: The End Effector Design