

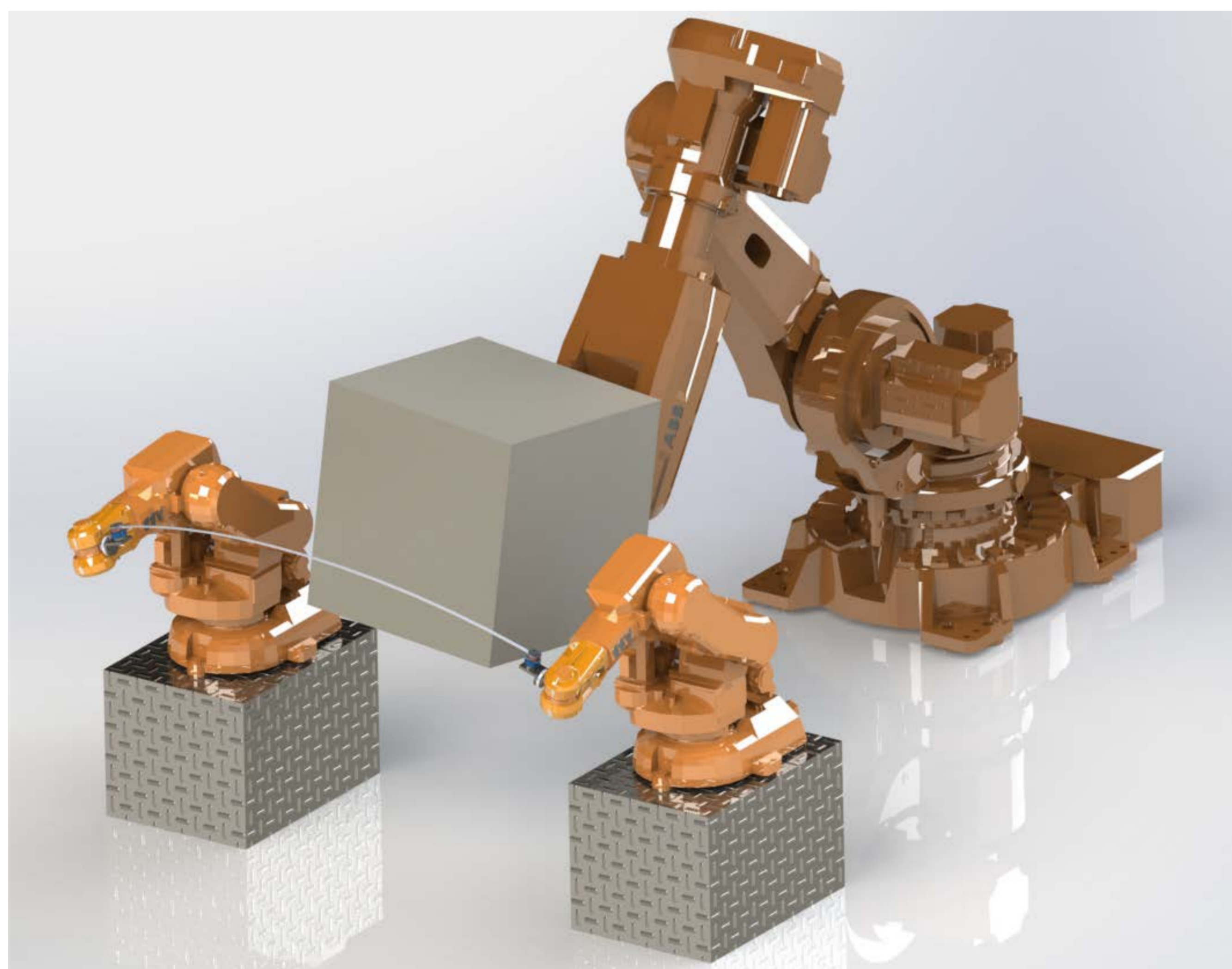
# Surface rationalisation for HotWire and HotBlade technology

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**Motivation** Milling and 3D-printing are used in producing small prototypes of geometric objects, but for large projects these methods become extremely expensive. For large-scale production, like the tower, the HotWire and HotBlade technologies could instead produce building elements by cutting out expanded polystyrene (EPS) moulds for concrete casting. Our work focuses on approximating CAD model surfaces by ruled surfaces or elastica-swept surfaces.

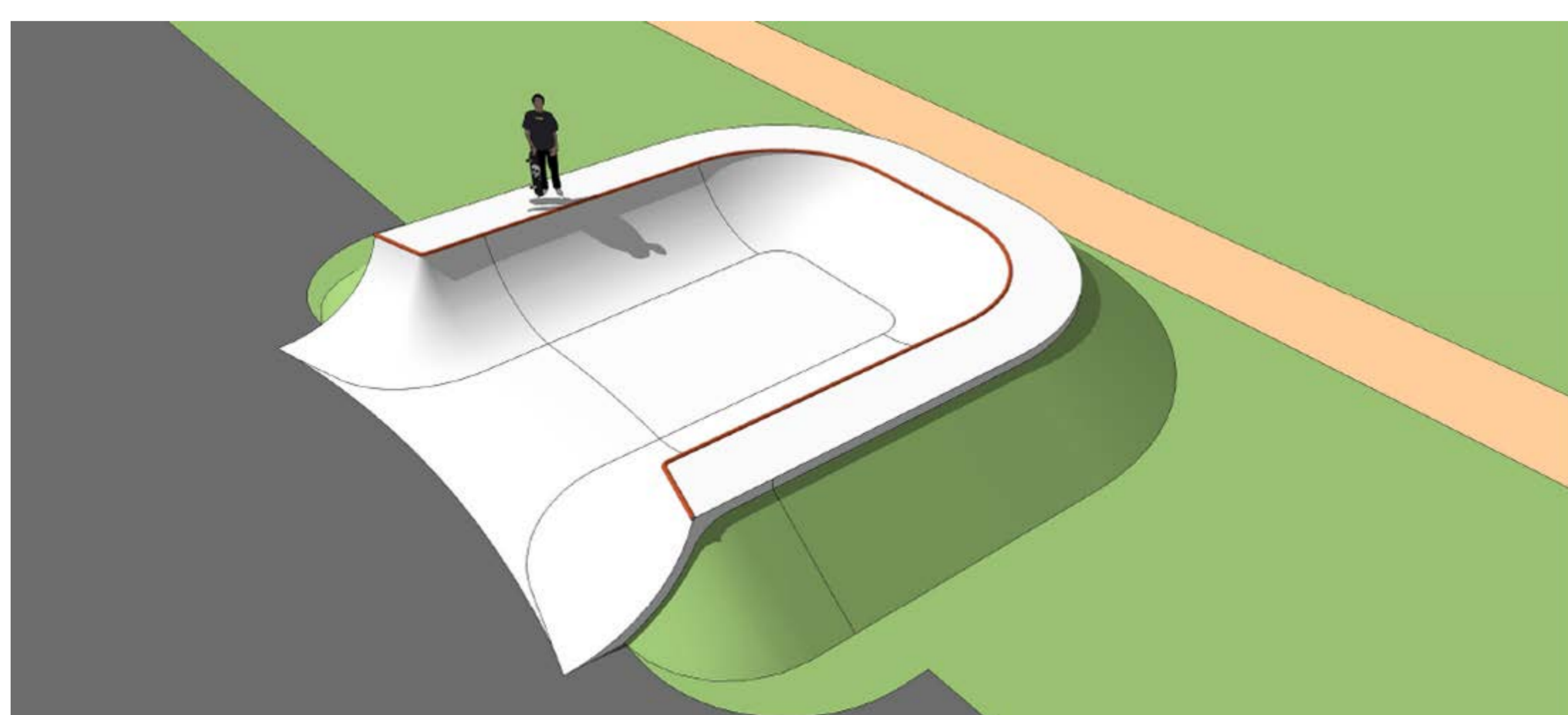


Design for mixed-use highrise building – 3XN



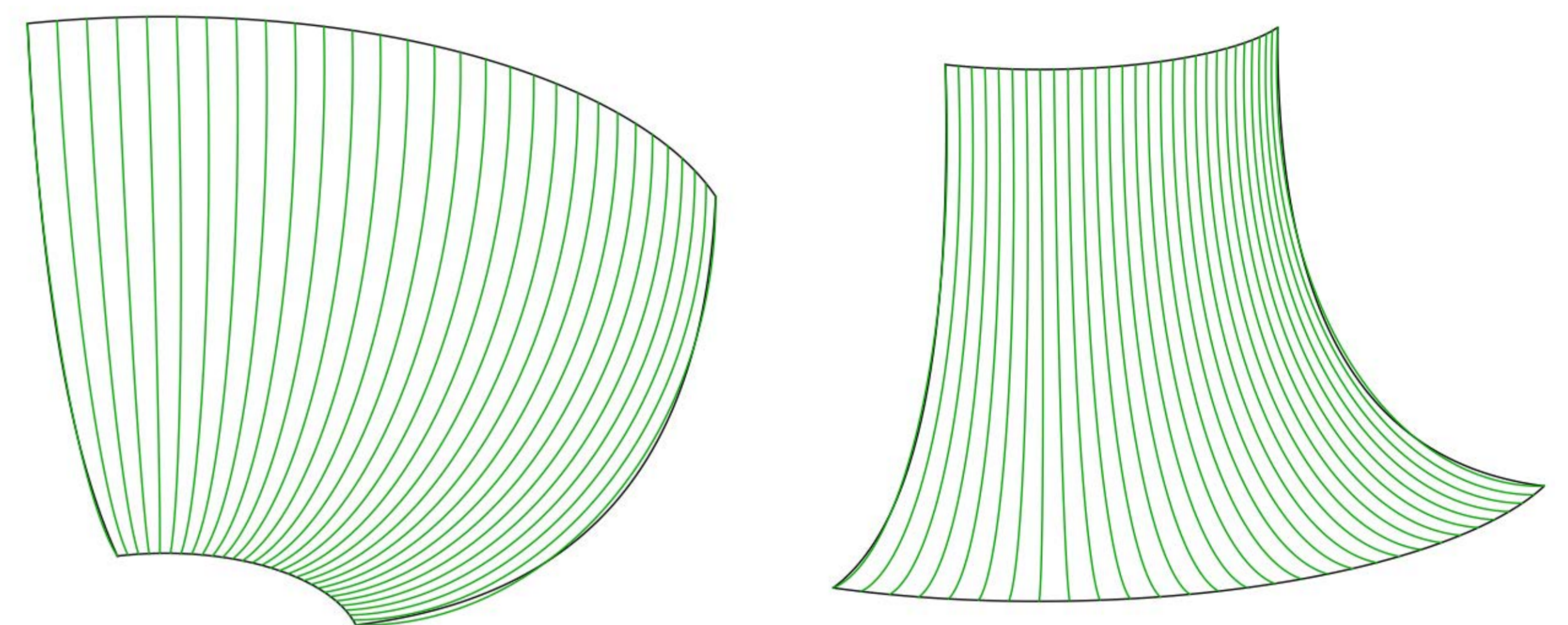
Robot setup for cutting EPS block using HotBlade – Danish Technological Institute

**Euler elastica, HotWire and HotBlade** The shapes that can be obtained by bending thin elastic rods are geometrically described by a collection of curves called Euler elastica. While the HotWire, being a straight line, can only cut ruled surfaces, the HotBlade is bent into the shape of an elastica, resulting in a curved cutting tool. The possible shapes of the HotBlade have closed form parameterizations.



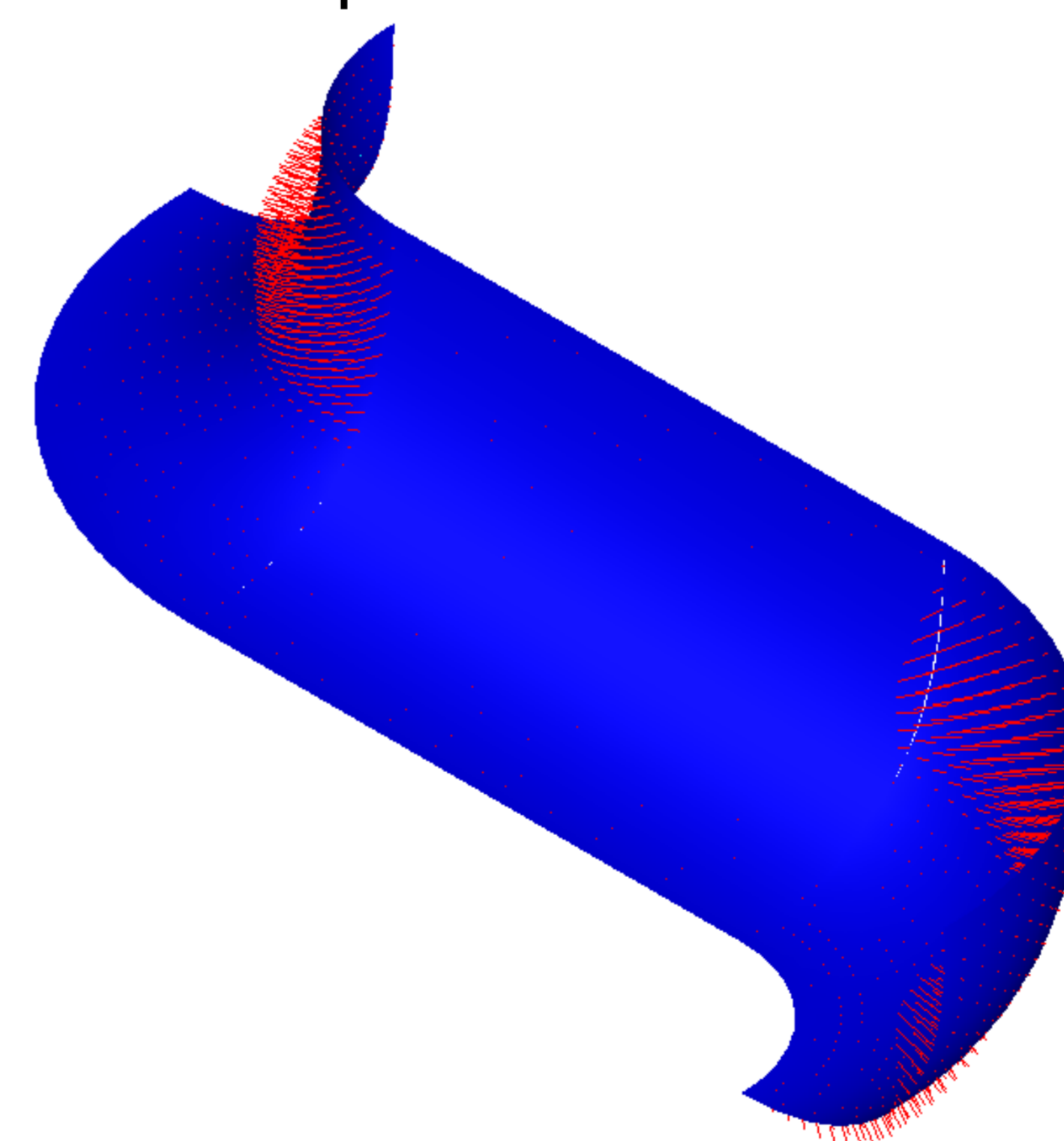
Skate park design modelled in Rhino.

**Method** Straight lines or Euler elastica are used to fit surface curves on a CAD model surface. The model surface is then approximated as a smooth collection of pieces that are either ruled or elastica-swept.



Elastica-swept skate park corners.

The approximation provides the control parameters for the HotWire and HotBlade, enabling cutting of an EPS mould. This allows fast production of concrete elements very close to the shape of the CAD model surface without milling.



Arrows show error  $\times 20$

Maximal error: 11.7 mm

Skate ramp height: 1.68 m

Approximation of the skate park.

## REFERENCES

Flöry, Simon, and Helmut Pottmann. *Ruled surfaces for rationalization and design in architecture*. Proceedings of the 30th Annual Conference of the Association for Computer Aided Design in Architecture (ACADIA), pp. 103-109. 2010.

Lawden, Derek F. *Elliptic Functions and Applications*. Springer-Verlag, 1989.

Euler, Leonhard *Methodus inveniendi lineas curvas maximi minimive proprietate gaudentes, sive solutio problematis isoperimetrici lattissimo sensu accepti* Additamentum 1. eulerarchive.org E065, 1744.