Bladerunner: Surface rationalisation for HotWire and HotBlade technology

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Motivation On a small scale, milling and 3D-printing are used in producing 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 styrofoam molds for concrete casting.

Our part of the BladeRunner project focuses on approximating CAD spline surfaces by ruled surfaces or surfaces that can be cut using the HotBlade.

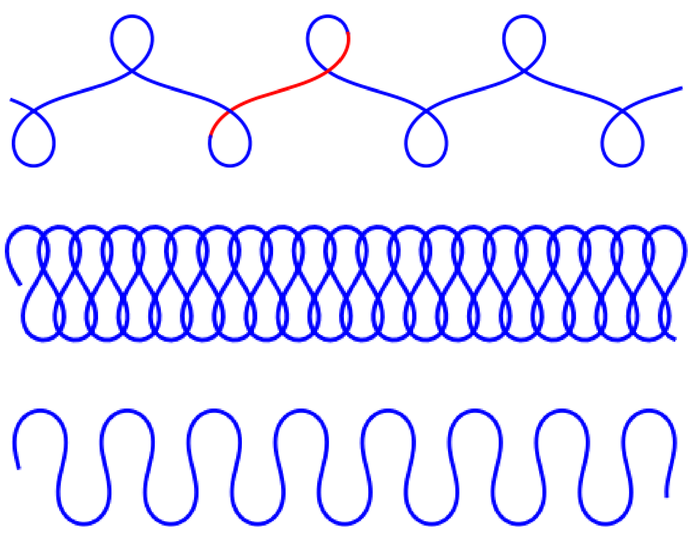
Design for mixed-use highrise building; 3XN architects

HotBlade and Euler elastica

The shapes that arise when thin elastic rods are bent are presented by a collection of curves known as Euler elastica. These curves can be parametrized in terms of elliptic functions:

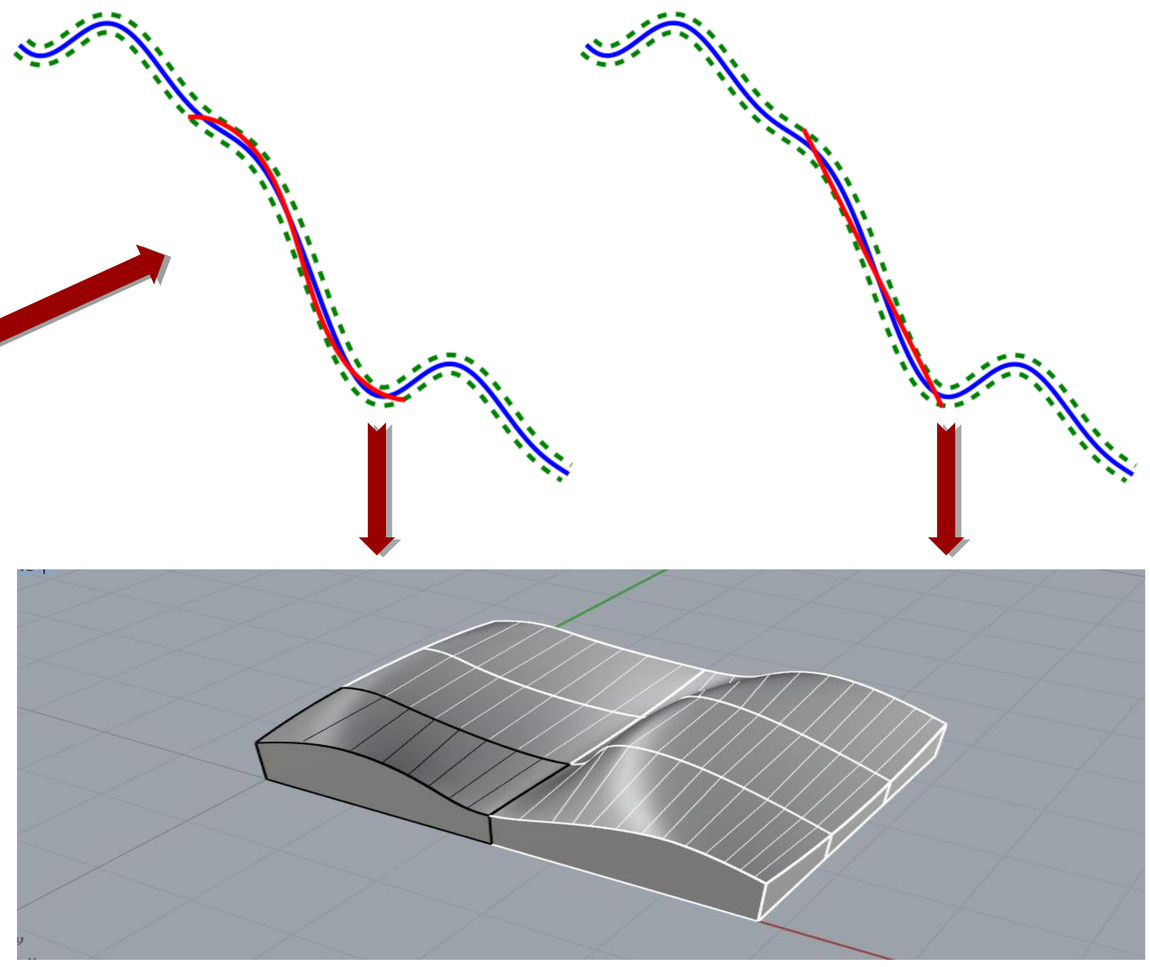
$$x(s) = \frac{2}{\omega}E(\omega s, k) - \frac{2k^2\,\mathrm{sn}(\omega s, k)\,\mathrm{cn}(\omega s, k)}{\omega\,\mathrm{dn}(\omega s, k)} - s$$

$$y(s) = \frac{2kk'\,\mathrm{sn}(\omega s, k)}{\omega\,\mathrm{dn}(\omega s, k)}$$



Method

Finding the longest elastica or stright line approximating a curve within a small error margin.



Euler elastica advantage

While the HotWire can only cut in straight lines the HotBlade takes the shape of an elasticum. This opens a new world of shapes that can be produced without milling.

Robot cutting styrofoam block using HotWire.

Goal

Using either the line or the Euler elastica to find the longest surface curve on a spline surface. Approximating the spline surface with a smooth collection of pieces cut by the HotWire and HotBlade technology.

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