TUTORIAL 3:   RANDOM / MOLDABLE ARCH

setting up the parametric construction

This part is the same as in Tutorial 1 and 2.

1. Start a new file in Cabri Geometry II *Plus*.

2. Turn the axes on.

3. Place point 1 anywhere on the drawing area (this point will control the position of your construction on the screen).

4. Draw a line through point 1, parallel to the x-axis.

5. Hide the axes again

6. Draw point 2 on the horizontal line through point 1. Point 2 will control the width of the arch.

creating the geometry of the random arch
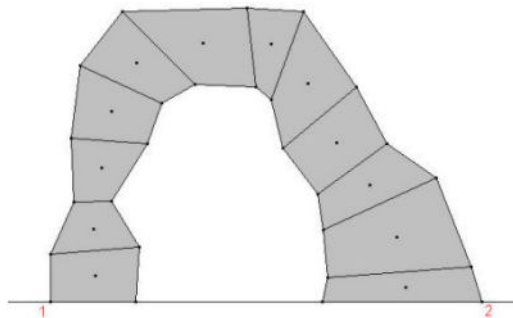
fig.1: a) The Delicate Arch in Arches National Park in Utah, USA, and b) a crude free formed arch that could start to look like one of these marvellous natural structures.

7. Draw the vertices (points) of the random blocks that will form your structure, as in fig.1.b.

8. Open the *centroid.mac* macro (cf. Tutorial 1).

9. Use the macro to find the centroids, draw the polygons, and find the areas of each block as in fig.1.b.

Result: We now have an arched structure that can be moulded to any shape by dragging the vertices of the blocks.

construction of the thrust line

We will now construct the compressive funicular line (= thrust line) for this structure, controlled by two points and an initial slope. Look at Tutorial 1 (option b) for a detailed description. The main steps are repeated here.

10. Draw vertical lines through the centroids and provide a vertical for the load line.

11. Transfer the values of the areas to the load line using the compass function.

Hints: You might want/need to scale the areas if you want to fit the funicular polygon on the screen. The funicular polygon is proportional, the actual scale is only important to afterwards read values of it.

12. Place points A and B on the supports, as in fig.2 (outside the vertical lines).
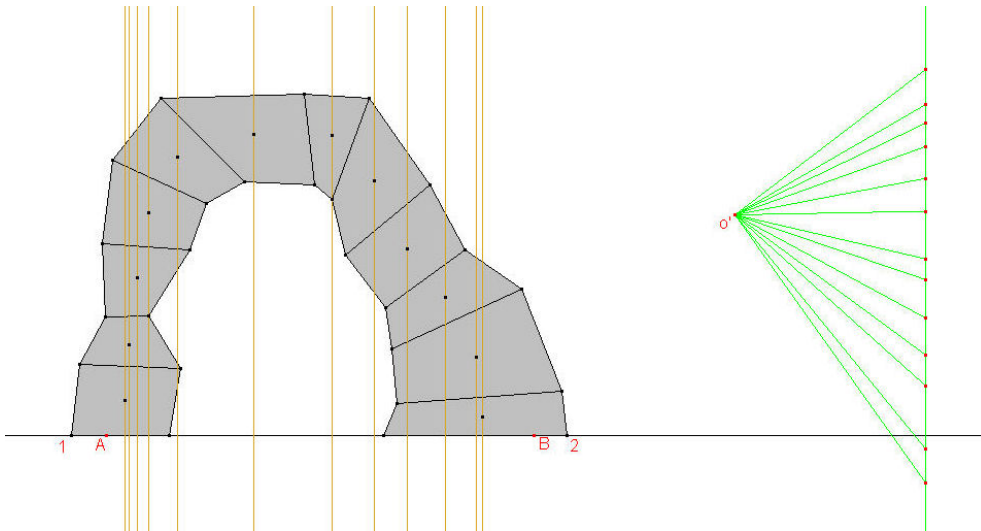
fig.2: Best place points A an B outside the verticals. It will become clear why this is when the construction is completed...

13. Pick a random pole o' to construct the helper funicular to find the resultant R. This is the vertical through the intersection of the first and last ray of the helper function (fig.3). *Notice that the helper function starts in point A but not ends in point B.*

14. Draw a line through A. This line will control the initial slope of the thrust line. Connect the intersection point r of this line with the resultant R with point B.

15. The actual pole o is the intersection of the parallel lines to the lines A-r and r-B through the top and bottom of the load line (fig.3).

16. Construct the thrust line using the initial slope as first ray (fig.4).
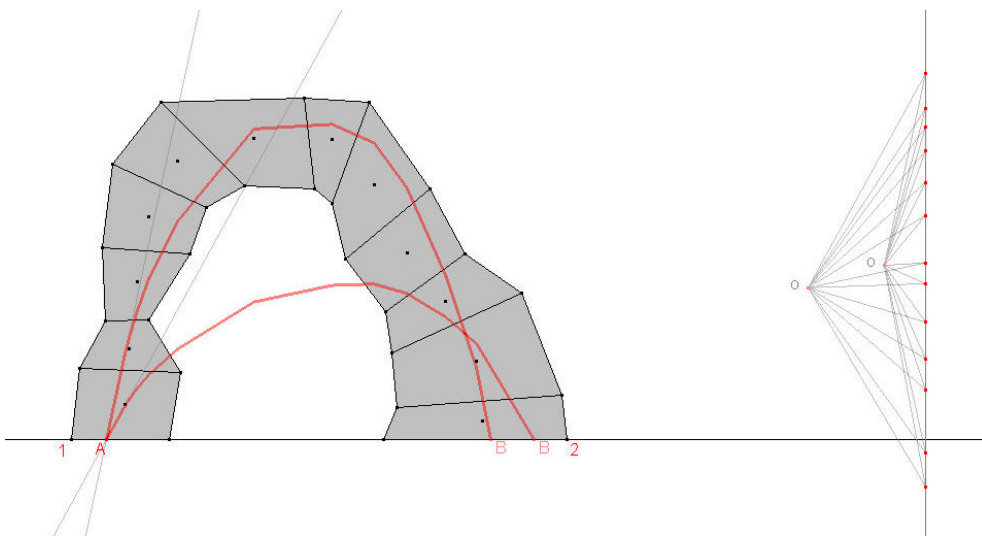
17. Change A, B and the initial slope to find the thrust lines that fit within the section (fig.5). *All the thrust lines fitting the section are possible equilibrium states.*
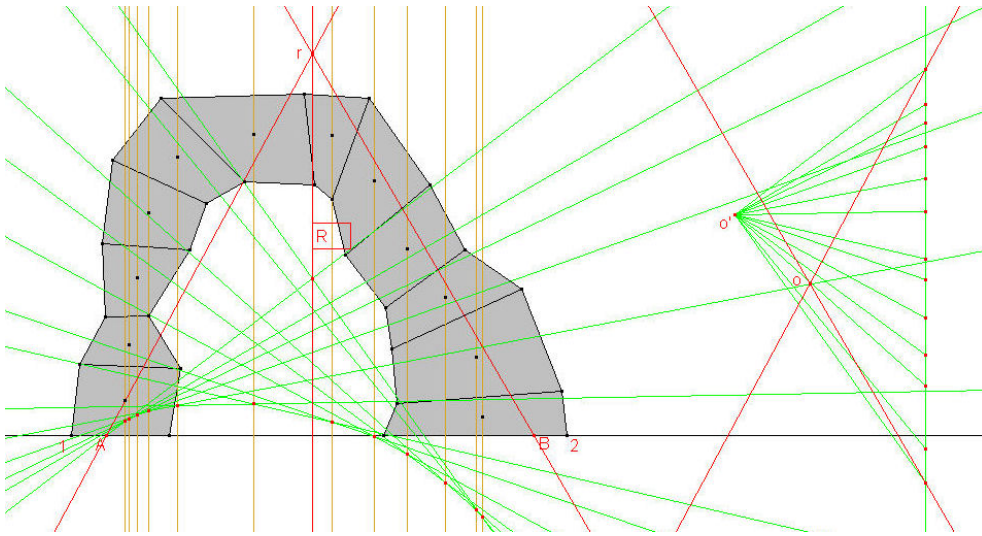
fig.3: The resultant R and the initial slope define r. Parallels to lines A-r and r-B define the actual pole o.
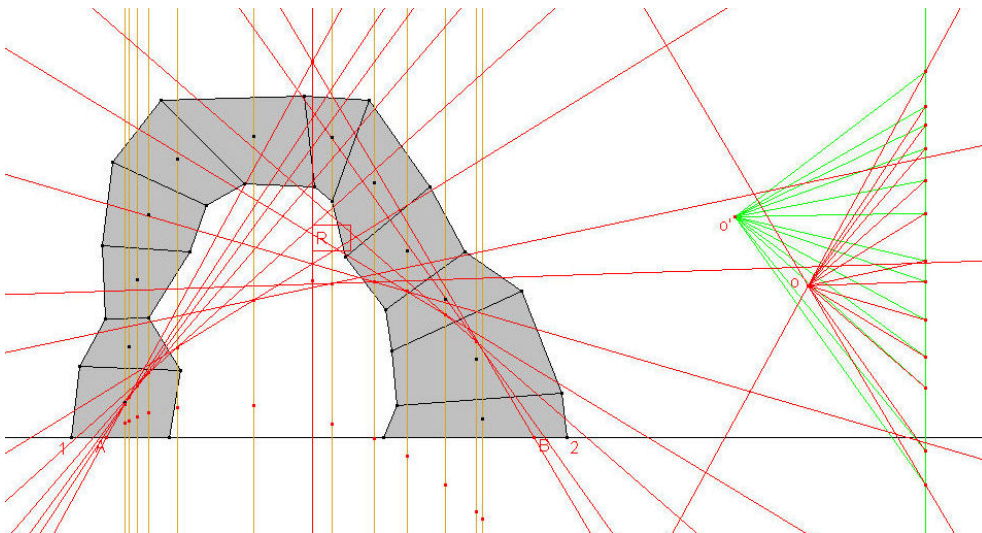
fig.4: The funicular construction that gives us the thrust line.

fig.5: Final model. Two lines are shown. Only the line that fits within the section is a valid equilibrium position.