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# Prove di CLIL //

## Morandi Bridge in Catanzaro


### Nicola Chiriano / Caterina Oliverio

Docenti al Liceo scientifico "Siciliani" di Catanzaro


[NICOLA CHIRIANO]

Nicola Chiriano è docente di Matematica e Fisica al Liceo scientifico "Siciliani" di Catanzaro. Si occupa di didattica e ICT. È formatore in diversi corsi per docenti e studenti di vari ordini di scuola. Ha all'attivo varie collaborazioni con Ansas (e-tutor nei corsi Pon Tec) e Invalsi (piani di formazione Ocse-Pisa e SNV). Su A&B ha già proposto un percorso tra Musica e Matematica.

[CATERINA OLIVERIO]

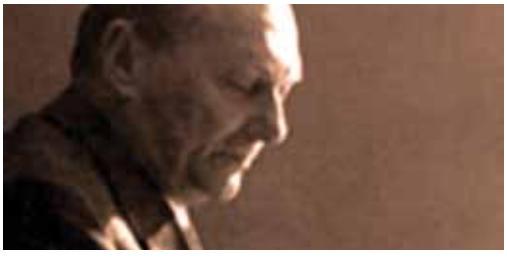
Caterina Oliverio, laureata in Lingue e Letterature straniere presso l'Università di Bari, è docente di Lingua e Letteratura inglese nelle scuole superiori dal 1992. Dal 2000 insegna al Liceo scientifico "Siciliani" di Catanzaro, dove si occupa di English for Specific Purposes. Collabora a contratto con la Facoltà di Medicina e Chirurgia dell'Università "Magna Graecia" di Catanzaro.

[TOPICS NEEDED]

- definition of a function
- properties of a parabola
- exponential functions

[OBJECTIVES]

- comparing parabola and catenary
- verifying the best fit slope of Morandi Bridge



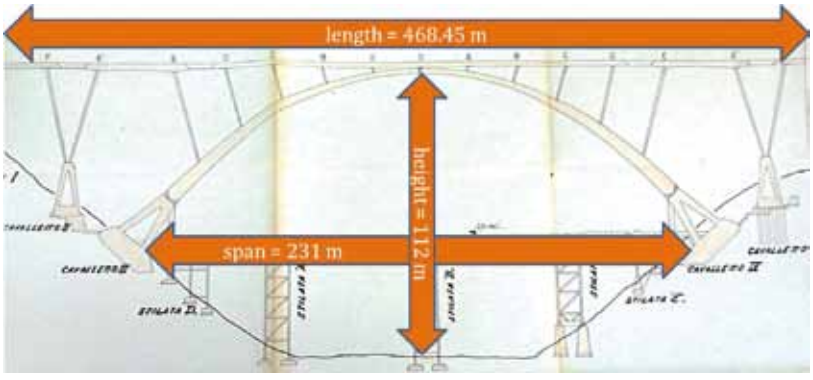
On the right: Riccardo Morandi.

http://it.wikipedia.org/wiki/File:Catanzaro_Il_ponte_pd.jpg

The majestic arch bridge connecting the two banks of Fiumarella valley is the landmark of Catanzaro, capital of Calabria, Italy. Made of concrete, it was completed in 1962, exactly 50 years ago, after the project idea of **Riccardo Morandi**, genial structural engineer and architect, who employed a giant arch centring. Thanks to its dimension, it has been awarded many records by the time of its realization as an unique concrete arch. Nowadays our bridge is named after **Fausto Bisantis**, an important politician from Catanzaro. On Pi Day 2012, we were able to present some results after a hard investigation work on the original projects by Morandi, kept on several files at Province of Catanzaro archives. Our main curiosity was about the shape of the arch: is it a parabola or is it something else?

## [NUMBERS & RECORDS]

| | | |
|---|---|---|
| Arch span: 231 m<br>Height: 112 m (above the level of the valley ground)<br>Length: 468.45 m (motorway)<br>Arch width: 10.50m on the top, 25m at the toe | **Among concrete arches in 1962**:<br>• the highest in the world<br>• with the highest centring in the world (> 120 m)<br>• the 2nd largest span in the world | **Today**:<br>• the 2nd highest in Europe<br>• the 11th largest span in Europe<br>• the 1st and unique for span, height and length in Italy |




## [PARABOLA OR CATENARY?]

At a first sight, our bridge could be described as a parabolic arch. But we've supposed that it could rather be a catenary, due to some properties of this curve. The shape of a hanging flexible line is not a parabola:

$$y = ax^2$$

like Galileo supposed. Huygens (1658) and later Leibniz and Johann Bernoulli (1691) showed that the correct equation is of the form:

$$y = a \cosh x/a$$

or, equivalently,

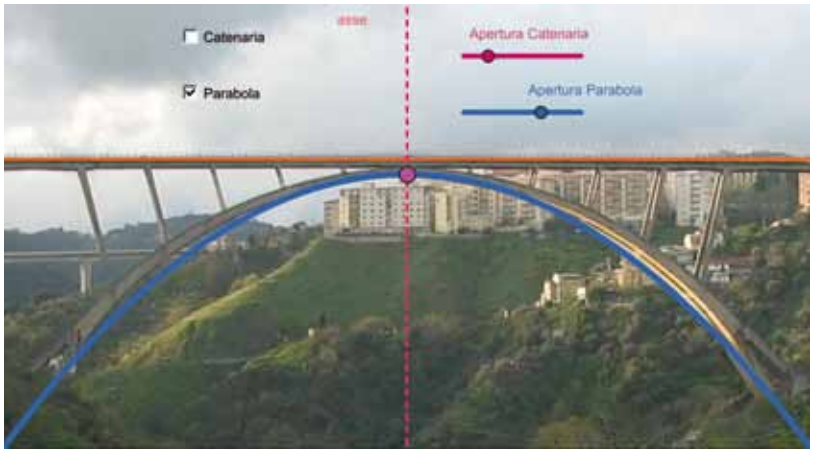
$$y = a/2(e^{x/a} + e^{-x/a})$$

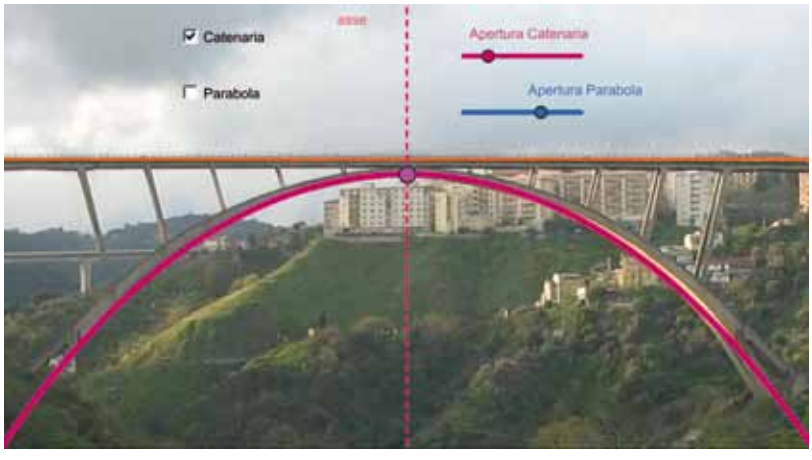
that is, the mean of two exponential functions if a = 1:

$$y = \frac{e^x + e^{-x}}{2} \quad .$$

A catenary is the curve of a rope (homogeneous, flexible and extensible) hanging at it ends under the only action of its weight. Therefore, its total weight is equally distributed to each point.

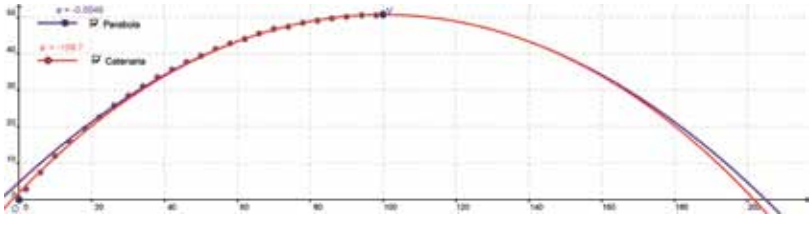
The "upside-down" version of a catenary arch is used in Architecture, because it minimizes the pressure on foundations. To check whether the curve of Morandi's arch is a parabola or not, we have used several methods: the simplest one was to use a centered picture, so as to identify the vertex V and another generic point at the base of the bridge, and draw by Geogebra the unique parabola passing through them. Then, we have used a catenary, and we have concluded that it fits better to the arch.



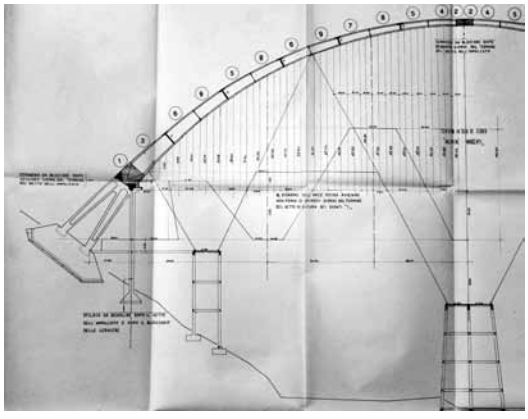




Parabola vs. Catenary

Fortunately, we've found in the archives a table in which Morandi shows the quotas of some arch segments with respect to their horizontal positions. In other words, he indicates the exact x and y coordinates of a set of points through which the curve he designed is unequivocally meant to pass. We have been working on this point to settle the question, and we have found that a catenary fits better the arch than a parabola.



Geogebra applet with the same (x,y) coordinates



The original Morandi's project.

[GLOSSARY]

**1. concrete :** calcestruzzo, cemento armato

**2. arch centring :** cèntina dell'arco, struttura portante temporanea in legno e acciaio

**3. Pi Day :** giornata mondiale della Matematica, si celebra il 14 marzo (3.14) di ogni anno

[THE FINAL PUN]

Something strange appears when searching "ponte Morandi" on Google.it…


http://www.youtube.com/watch?v=L8tolVApESo

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