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CATENARY CURVES – A CASE STUDY

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ABSTRACT :

A rope or chain , which is hung with the support of two poles forms a curve like parabola , but in fact it is not parabola ,the curve name is Catenary curves.The Catenary is also called as alysoid or chainette. Mathematically the graph of catenary curve is hyperbolic cosine function curve. The surface of revolution of catenary curve forms a catenoid , which has the minimal surface of revolution. catenary curves finds many application in architecture , electrical supply lines and offshore industry. The upcoming report says about the applications and more about catenary curves.

Keywords : Catenary curve, Hyperbolic cosine function ,Catenoid, architecture

INTRODUCTION :

We all must have seen this curve everywhere in our surrounds ,but we think this is a parabolic curve. But in fact the curve is called Catenary curves. These play a important role in architecture field. These curves are hyperbolic cosine function curves. The surface revolution of the catenary curve has the minimal surface of revolution. curves finds application in engineering field, construction , oil and gas industries and many more.

CATENARY CURVE :

The word Catenary is derived from the Latin word catena, which means chain. Catenary curve is a hyperbolic cosine function curve. Galileo was the first to explore the catenary, yet he mixed up it for a parabola. James Bernoulli in 1691 got its actual shape what's more, gave a portion of its properties.

Galileo's proposal that an overwhelming rope would hang in the shape of a parabola was invalidated by Jungius in 1669, however the genuine state of the catenary, was not found until 1690– 91, when Huygens ,Leibniz and John Bernoulli

answered to a test by James Bernoulli. David Gregory, the Oxford professor, wrote an extensive treatise on the 'catenarian' in 1697.The name was first utilized by Huygens in a letter to Leibniz in 1690.

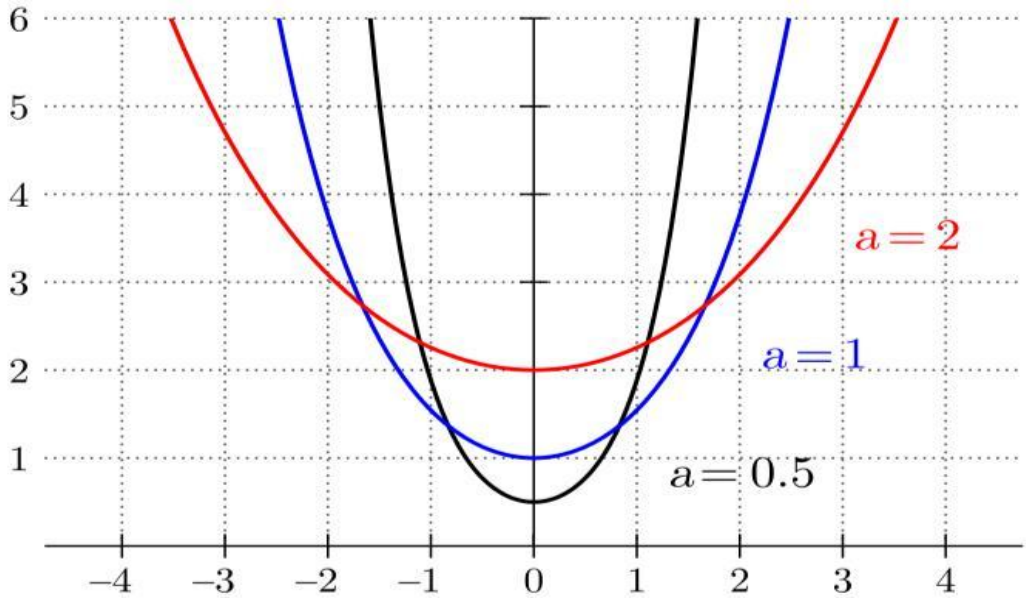
The spider web are also a catenary curves which is joined to two long silk webs.

CATENARY CURVE EQUATION AND GRAPH :

The cartesian coordinates catenary curve equation is

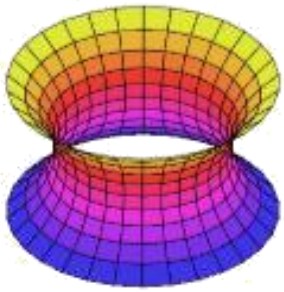
y = acosh(x/a)

The graph for different values of a in hyperbolic cosine function is shown below :



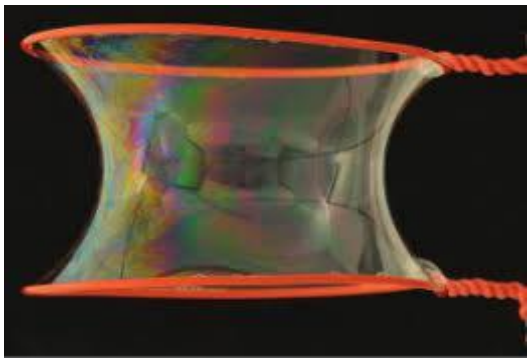
CATENOID :

Catenoid is the surface of revolution of catenary curve which has the minimal surface area. The soap bubble formed between the two circular ring is an Catenoid. The catenoid application is used in construction field when they need to construct with low or minimum surface area.



This is the shape of a Catenoid.

This is the catenoid formed by a soap bubble with two circular rings.



ARCHITECTURE WITH CATENARY CURVES :

Catenary curve finds a good application in architecture field. The catenary arch is very famous.A catenary arch is an inverted pointed arch that follows catenary curve.The catenary arch with uniform thickness and density is one of the strong curve.

Even the igloos are designed with the help of cross section of catenary curve.This shape offers an optimal balance between diameter and height , avoiding the risk of collapsing under the weight of compacted snow.

The reversed catenary is a perfect shape for curves as its physical properties guarantee that the curve bolsters itself. Potters utilize catenary ovens therefore. In a furnace the outrageous contrasts in temperature make issues in the respectability of the structure. Furnaces worked in roundabout shapes require extra structure to safeguard their uprightness; be that as it may, ovens worked in the state of a catenary don't have a similar issue. It is fascinating to take note of that despite the fact that it is conceivable to discover conditions to use to manufacture catenary furnaces, the normal guidance is to hang a chain, follow it, rearrange it, and afterward utilize the portray for your plan.

These are some pictures of architecture by using the concept of catenary curves.

ELECTRICAL WIRE CATENARY :

You might have seen electrical connection wire hanging little low and not straight. The electrical wire forms the catenary curve due to elongation of the wire. The electrical connection wire elongates due the heat and gravity. Due to the sunlight , the metal present in that electrical wire expands and forms a catenary curve. The curve formed by electrical wire should have a value more than 2 (a>2)in the hyperbolic cosine equation.

This is the catenary curve formed by electrical wire due to elongation

BRIDGES IN THE FORM OF CATENARY CURVE :

We all should have seen that the fencing chain is hanging and not straightly connected to the poles. The same ideology is used for hanging bridges which is resembled to the hanging chains in the fencing. The hanging bridges are constructed with the help of catenary curves concept. When the two corners of the wire is connected to a rigid support , the curve formed by the action of gravitational force is catenary curve.

ANCHOR :

The catenary delivered by gravity gives leverage to overwhelming anchor rodes. An anchor rode (or anchor line) for the most part comprises of chain or link or both. Anchor rodes are utilized by boats, oilrigs, docks, gliding wind turbines, and other marine gear which must be anchored to the seabed. At the point when the rode is slack, the catenary bend introduces a lower edge of draw on the

anchor or mooring gadget than would be the situation in the event that it were almost straight. This upgrades the execution of the anchor and raises the dimension of power it will oppose before hauling. To keep up the catenary shape within the sight of wind, a substantial chain is required, so just bigger ships in more profound water can depend on this impact. Littler vessels likewise depend on catenary to keep up most extreme holding power.

CONCLUSION :

Catenary , architecture and art all goes haad in hand with each other. For constructing strong and peak arches we use catenary to make it easy. Catenary curves is everywhere in our part of our life. For the construction of hanging bridges the value of 'a' should be more than or equal to 4 , or else the curve will be peak curve , which cannot be suitable for bridges. If 'a' value is less than 4 then bridge will not be stong and people cannot use it.

The arches and monuments can have a peak inverted catenary and all the values of 'a' can be substituted to make different structures and different types of catenary arches.The electrical supply line also forms a catenary curve , these curves can have 'a' value greater than 3 or else the electric supply wire will be very close to the ground and may cause many accidents.So these above details should be used before using the application of catenary curves.

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