International Journal of Science Academic Research
Vol. 03, Issue 11, pp.4725-4728, November, 2022
Available online at http://www.scienceijsar.com
ISSN: 2582-6425

Research Article

HIGH EFFICIENCY HYDRO- POWERPLANT WITH BRACHISTOCHRONE CURVE PIPE

***Ganesh, M., Sethuraman, N., Dr. Rangasamy, V., Navinkumar, S. and Dhinagaran, S.**

IFET College of Engineering, Villupuram, Tamilnadu, India

Received 27th September 2022; **Accepted** 25th October 2022; **Published online** 30th November 2022

Abstract

In this paper, new approaches to find the approximate solution of the Brachistochrone problem numerically determine the time function to optimize, and then compute the segment of the cycloid as the solution to a non-convex numerical optimization problem using interval method. In interval method it gives more accurate and approximate solution of real life situation and numerical illustrations are given. The analytical solution to the Brachistochrone problem is a segment of circumference of the circular disk rolling on a flat surface. In this paper we present the computation of this segment of the cycloid as the solution to non-convex numerical optimization problem

Keywords: Hydro- Powerplant, Curve pipe.

INTRODUCTION

The Brachistochrone (curve) is the curve on which a massive point without initial speed must slide without friction in a uniform gravitational field in such manner that the travel time is minimal among all the curves joining two fixed points. The Brachistochrone curve is a classic physics problem, that derives the fastest path between two points A and B which are at different elevations. Although this problem might seem simple it offers a counter-intuitive result and thus is fascinating to watch. In this instructables one will learn about the theoretical problem, develop the solution and finally build a model that demonstrates the properties of this amazing principle of physics. In this project we will discuss about the importance, working and enlisting the purpose of curves and it's uses.

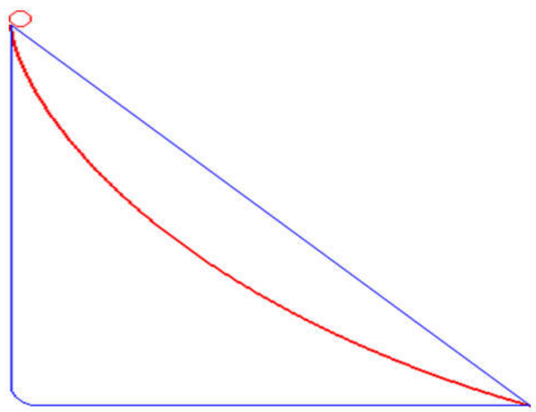

Fig.1: Brachistochrone curve

Construction

- The model consists of lasercut paths that act as tracks for the marbles. To demonstrate that the Brachistochrone curve is the fastest path from point A to B we decided to compare it with two other paths.
- We decided to put a straight slope connecting both points as the second path. The third one is a steep curve, as one would feel that the sudden drop would generate enough speed to beat the rest.
- The second experiment in which the balls are released from different heights on three Brachistochrone paths, results with the balls reaching at the same time.

Fig.2. Brachistochrone Curve

Working

- The Brachistochrone curve is the same shape as the tautochrone curve; both are cycloids. However, the portion of the cycloid used for each of the two varies.
- At the limit when A and B are at the same level, but always starts at a cusp.
- In contrast, the tautochrone problem can use only up to the first half rotation, and always ends at the horizontal.
- The curve is independent of both the mass of the test body and the local strength of gravity.
- Only a parameter is chosen so that the curve fits the starting point A and the ending point B.
- If the body is given an initial velocity at A, or if friction is taken into account, then the curve that minimizes time dif fers from the tautochrone curve.

Corresponding Author:** ***Ganesh, M.,
IFET College of Engineering, Villupuram, Tamilnadu, India.

Reason

- When the shape of the curve is fixed, the distance may be found, and dividing this by the velocity yields the duration .
- The straight line was the slowest, and the curved line was the quickest. The difference between the ellipse and the cycloid was slight, being only 0.004s.

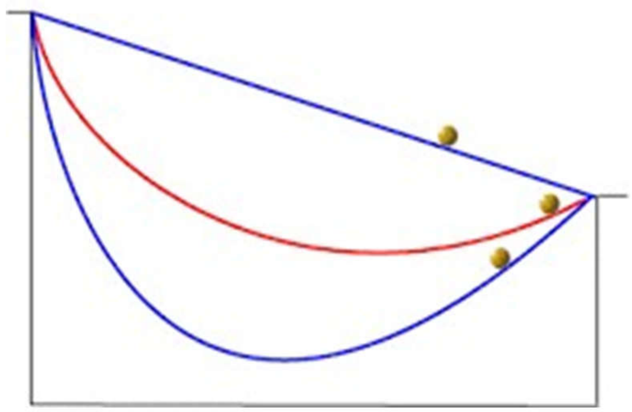

Fig.3.The RED Brachistochrone (Inverted cycloid) curve is the curve of fastest descent between two points

APPLICATION

- Brachistochrone curves are useful for engineers and designers of roller coasters. These people might have a need to accelerate the car to the highest speed possible in the shortest possible vertical drop.
- A Brachistochrone curve, meaning 'shortest time', or curve of fastestdescent, is the one where a bead slides frictionless under the influence of a uniform gravitational field to a given end point in the shortesttime.

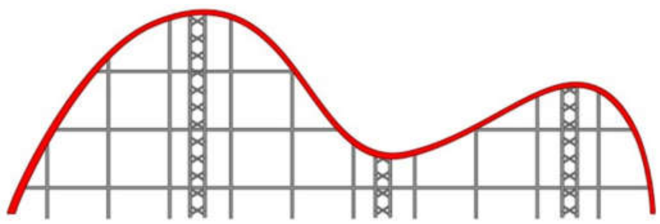

Fig. 4.Brachistochrone curve using Roller Coaster

Brachistochrone curves in dams

The Brachistochrone Problem contemplates the shape of the path between two points, on the same vertical plane. The Brachistochrone Problem deals with a single point mass rolling down a curve from one point to another, not fluids like water. ... If the water could flow faster through these cycloid-shaped pipes, then the power generated by the turbines would increase.

Hydro-power plant construction

- Hydroelectric dams are designed to take advantage of the conversion of water's potential energy to kinetic energy, and then mechanical energy to electrical energy.The force of kinetic energy is dependent on the height and mass of the falling water after all it isgravity.
- Engineers take into consideration when designing dam turbines. Higher kinetic energy caused by the same amount of water falling from a higher distance results in more force on the turbine blades, and engineers design the blade and the assembly to withstand this force.
- The technology behind hydro power is fairly simple, but the power of water is a major challenge. Hydro power plants are expensive to build, but inexpensive to operate.
- Modern hydro power plants have dams that may be over one hundred metres high, huge man-made lakes and turbines weighing hundreds of tonnes.

Water reservoir

- Dams create reservoirs that allow for greater heights of fall and also serve to regulate energy withdrawal. Water is stored and used when electricity demand is the greatest.
- The water is directed from the reservoir to a lower level through tunnels, passing a turbine on the way. The type of turbine used depends on the size of the power plant, height of fall and other conditions. The Francis and Kaplan turbines are the most common types, used chiefly in hydro power plants with medium heights offall.
- Hydro power plants with higher heights of fall normally use a Pelton turbine. A generator then converts the mechanical energy generated by the rotating turbine shaft into electrical energy, a transformer increases the voltage and the electricity is transmitted to the grid.

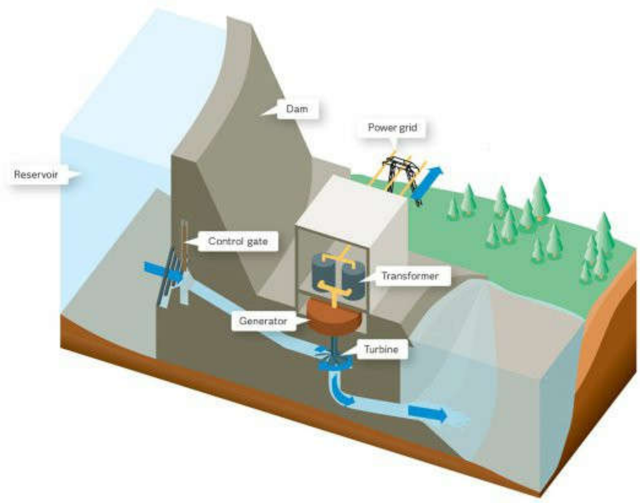

Fig. 5. Water Reservoir diagram

Conversion

- Large dams trap the water in reservoirs to create the necessary fall height and to store some water for later use. The water falls to a lower level, passing through the turbine. The turbine axel rotates and powers thegenerator.
- The generator converts the rotating movement of the turbine into electrical energy. The transformers regulate the voltage so it is appropriate for the power grid
- Hydro-powerplant can be situated in hilly region where high head is available or in plainer region where low head high discharge is available.

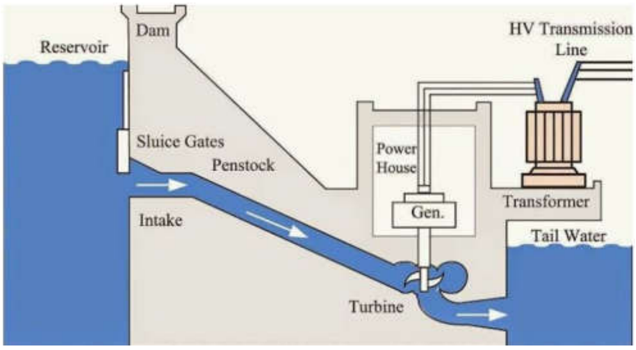

Fig. 6. Conversion diagram

Penstock construction

- It's essential a very large diameter pipe, built in sections, that conveys water from the reservoir and brings it to a hydroelectric powerhouse where the hydro turbines are placed. The powerhouse is much lower elevation than the reservoir.
- The penstock is typically buried but can be above ground. Sometimes both buried and aboveground. The penstock allows for expansion and contraction.
- The penstock is inspected on a regular basis. There are gates at the top of the penstock and at the bottom of the penstock where it enters in the powerhouse.
- Diameters are different depending on how much water flow is designed for the turbines. Sometimes each turbine has their own penstock. Other times a single penstock will bifurcate for two fixed quantity of water is used to generate hydro electricity arises in very ideal situation.

Hydro-power plant

- Hydropower, also known as water power, is the use of falling or fast-running water to produce electricity or to power machines.
- This is achieved by converting the gravitational potential or kinetic energy of a water source to produce power.
- Hydropower is a method of sustainable energy production

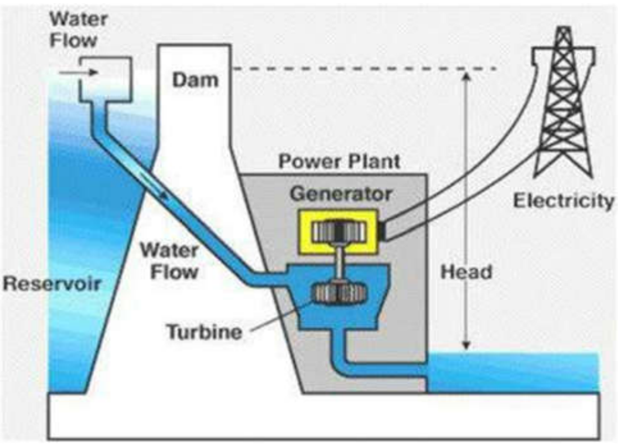

Fig.7.Visual observation of dam

Energy needed to get 1mw

- In general, the 'out of pocket' calculation is: P=8Qh
- Where P is the power generated, in kW, Q is the flow of water, in cubic metre per second, and h is the head available at the site, in metre. The factor 8 accounts for hydraulic and electromechanical losses.
- Suppose you want to generate 1000 kW (1 MW) and have 80 m of head available. Therefore, you'll need:
- Q =P/(8h)
- Q=1000/(8∗80)=1.56m3/s
- Basically, a small river running down a small hill. The more head, the less water.

Price in construction

- Probably it is cheaper to make a high level and a low level water lake on land, the high level lake on top of a hill or mountain.
- The way we need to construct a dam and a pipe between the two lakes.
- It would be cheaper than constructing something down in the sea. But to get good depth, you would have to go some distance away from the land.
- But, yes, it is a way of storing energy and recovering some of that energy later.

Types of brachistochrone curve dams

Type 1. Curved path with low velocity flow

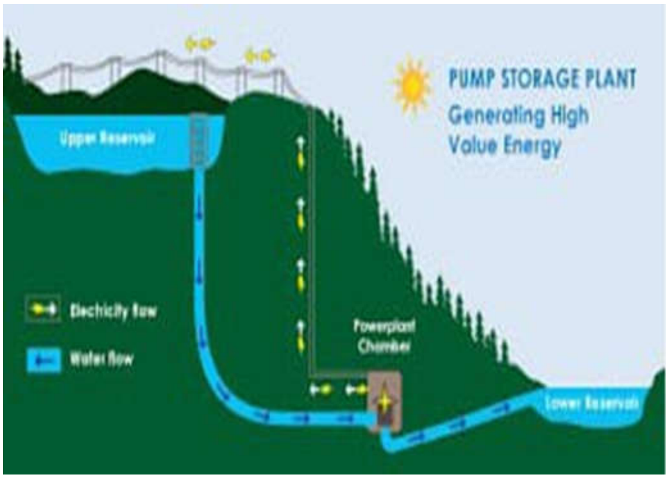

Fig. 8. Curved path with low velocityflow

TYPE 2: Straight path with low velocity flow

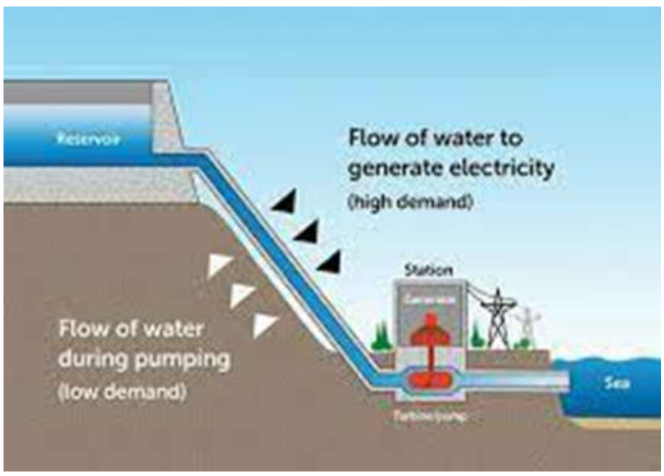

Fig.9. Straight path with low velocity flow

TYPE 3: Curved path with high velocity flow

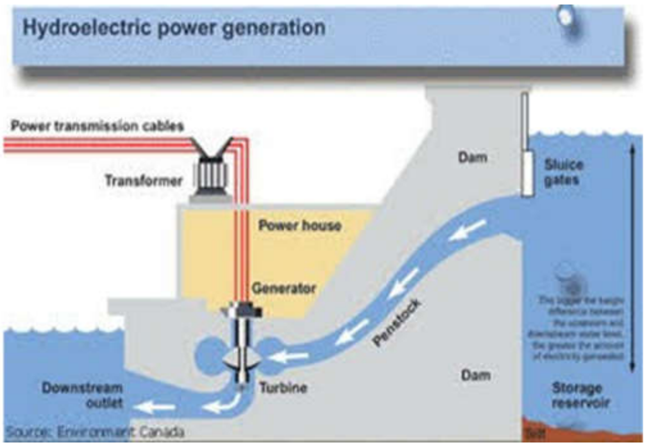

Fig. 10.Curved path with high velocity flow

Model

Fig. 11. Side view

Model

Fig.12. Front view

Brachistochrone to tautochrone curve

The curve is independent of both the mass of the test body and the local strength of gravity. Only a parameter is chosen so that the curve fits the starting point A and the ending point B. If the body is given an initial velocity at A, or if frictionis taken into account, then the curve that minimizes time differs from Tautochrone curve.

Conclusion

The Brachistochrone curve is the same shape as the Tautochrone curve; both are cycloids. However, the portion of the cycloid used for each of the two varies. More specifically, the Brachistochrone can use up to a complete rotation of the cycloid but, always starts at a cusp. In contrast, the Tautochrone problem can use only up to the first half rotation.

REFERENCES

Chisholm, Hugh, ed. 1911. "Brachistochrone". Encyclopædia Britannica (11th ed.). Cambridge University Press.

Sagan, Carl, 2011. Cosmos. Random House Publishing Group. p. 94. ISBN 9780307800985. Retrieved 2 June 2016.

Herman Erlichson, 1999. "Johann Bernoulli's Brachistochrone solution using Fermat's principle of least time", *Eur. J. Phys.,* 20 (5): 299–304, doi:10.1088/0143-0807/20/5/301

Sagan, Carl, 2011. Cosmos. Random House Publishing Group. p. 94. ISBN 9780307800985. Retrieved 2 June 2016.