2012 年臺灣國際科學展覽會

優勝作品專輯

國家：India

編號：010061

作品名稱

The use of Square shaped wheels in ship harbouring using an inverted catenary surface

得獎獎項

四等獎

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SYNOPSIS

The main idea is of the creation of a Square wheel to be installed in Transports like Ships in order for them to climb up and down the dock lines during low tides when it is impossible to do so. This wheel's square design gives the result of the formation of wheels that have better grip than any other design and have lesser inertia and also have lesser power required in order to move them. In the snowy areas too, when the roads become slippery due snow melt, these wheels provide very high grip and avoid slip of vehicles.

A square wheel can roll smoothly by,

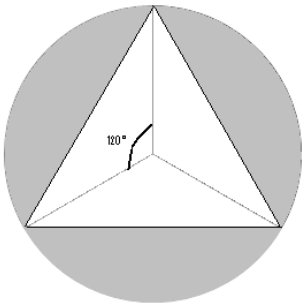
- keeping the axle of the vehicle moving in a straight line and
- coinciding each side of the square wheel with each bump of the inverted catenary shaped road,

The square wheel with axle at same level running on inverted catenary surface

Now we took the side of the square wheel as 22 cm so we get the length of each bump of road as 22 cm and then we applied the formula of

Length of arc (i.e. each inverted catenary) = θ/360° *(2πr)

By taking different values of θ, and finding the corresponding radii of the circle, we finally concluded that 120°was the best suited angle. Thus by taking θ as 120°, we get the radius of the circle as 10.2 cm



Each shaded portion represents a bump.

Hence we divide a circle of radius 10.5 cm into 3 parts of 120° each and join the edges to get the 3 curves of our road on which the square wheels would move and help the ships climb the dock, eliminating the role of tides in its harbouring.

ABSTRACT

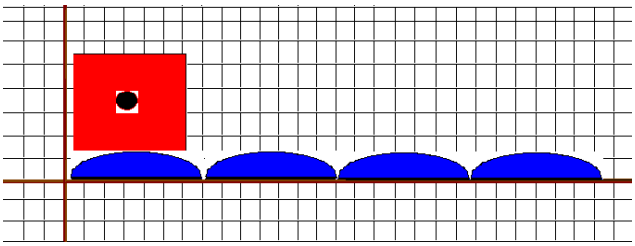
Riding around on a flat tire is no fun. It feels really bumpy. But a square wheel may be the ultimate flat tire. There's no way it can roll over a flat, smooth road without jolting the rider again and again.

Here, I have constructed a bicycle with square wheels. It's a weird contraption, but you can ride it perfectly smoothly. My secret is the shape of the road over which the wheels roll.

A square wheel can roll smoothly, keeping the axle moving in a straight line and at a constant velocity, if it travels over evenly spaced bumps of just the right shape. This special shape is called an inverted catenary. A catenary is the curve describing a rope or chain hanging loosely between two supports.

A hanging chain

Turn the curve upside down, and you get an inverted catenary--just like one of the bumps in my road. Make the road out of a whole bunch of those bumps all in a row, and you can take your square-wheeled bike for a quick spin.



Just as a square rides smoothly across a roadbed of linked inverted catenaries, other regular polygons, including pentagons and hexagons, also ride smoothly over curves made up of appropriately selected pieces of inverted catenaries. As the number of a polygon's sides increases, these catenary segments get shorter and flatter. Ultimately, for an infinite number of sides (in effect, a circle), the curve becomes a straight, horizontal line.

In the end, I conclude with possible enhancements in the project that might take us to a whole new world.

The above mentioned content is the ABSTRACT expressed in around 550 words. Pls allow the same.

Details to Cases are reflected in attached below pages:

INTRODUCTION

We all have seen cycles with circular wheels. Every two second we see one. But have you ever imagined a cycle with square wheels?? Probably no!!! no one has spare time to think over such a topic. Even I would have not thought about it until I saw an episode on the television. The episode highlighted problems faced by ships during their climbing up and down the dock. It stated that ships could climb up the dock during high tide only, and climb down during low tide only, and because of this, countries face a lot of damage.

Then I thought if this is the only reason of it then why not change it a bit and do something in order to end this problem. I found that in high tide, due to the pressure of water, the ship moved back and could not come down. The main reason was that the wheels could not make proper grip with the surface of land. So I thought why not change the wheels?? Hence came up the idea of square wheels. But for these wheels to move on road, the road had to be changed. Therefore, gradually I came up with the road of inverted catenary shape.

And from here came the idea of a vehicle with square wheels running on a surface of inverted catenary shape.

METHODOLOGY AND EXPERIMENTAL DETAILS

I found the most challenging engineering component of creating a square wheel bicycle to be the design of the wheels and the track. They had to be sturdy, yet not too heavy, and roll smoothly. I began with a traditional bicycle and saw what makes it move swiftly. I came up with the following two points-

- The axle always remains at the same level and perpendicular to the ground
- Each infinite side of the circular wheel coincides with each infinite side of the plane.

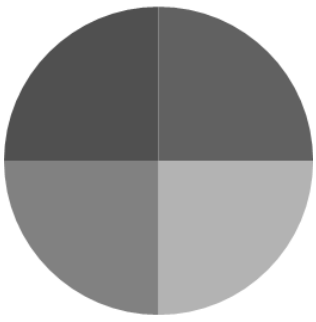
So I had to put these two conditions in my cycle for it to move smoothly.

Now since these conditions couldn't be fulfilled with a plane surface,the major challenge before me was to change the surface. And surface had to be such that the diagonal of the wheel (which is the longest length that can be constructed in a wheel)should touch the lowest point of the track and the side of the wheel (which is the shortest length that can be constructed in a wheel) should touch the highest point of the track, then only the axle would remain at same level always.

There is only one shape that fulfils this phenomenon i.e. of inverted catenaries, therefore it was best suited for a square wheeled bicycle. Now the side of the wheel and the arc of the catenay had to be in some proportion. So in order to establish a relation, I had to do something. Since inverted catenary is a part of a wheel so I started of with a square wheel with side of 22 cms. Just to simplify my calculations as it would involve the concept of "π" i.e. 22/7.

Then I made a rough circle and initially divided it into four equal parts-

1st interpretation -



One arc = side of square

= 22 cm

Radius = ?

Now acc. To the formula-

Length of arc = $\theta/360° * (2\pi r)$

⇨ $22cm = 90°/360° * (2\pi r)$

⇨ $r = 22*4 / 2\pi$

⇨ $r = 22*4*7 / 2*22$

⇨ $r = 14$ cm

2^{nd} interpretation -

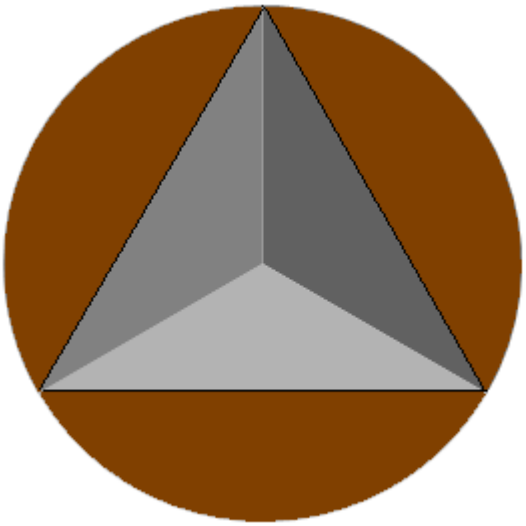
By same formulae, r = 10.5 cm

3^{rd} interpretation -

By same formulae, r = 8.4 cm

But by a practical view 90° would be very steep, 120° would be appropriate, 150° would resemble more of a straight line. Hence 120° is best suited.

So,



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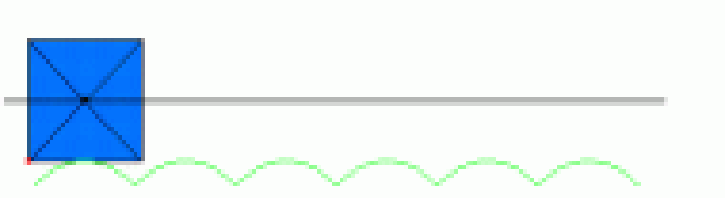

Hence my road was made.

RESULTS

Hence after much experimentations, our project “THE SQUARE WHEEL: A NEW APPROACH” has been successfully completed.

And through this project, we have proved that Square wheeled cycle is not a dream and it can swiftly run on a road of the shape of inverted catenary.

FUTURE PLAN

If my project gets recognition, I would like to intensify my project and would like to-

1. Construct the moulded road of a very strong material which is made by burning plastic and it is waterproof. So it will not wear and tear during the rainy season as does our normal roads. Moreover it would cost very less as we are using or let me say, "reusing" the plastic garbage thrown away. It would not only help us constructing the road but also help –
    - To save lives of many cows as they generally eat plastics on roads and it becomes a cause of their death,
    - Increase income of the garbage pickers and generate employment for them, and
    - Stop the choking of the drains as plastics obstruct the path of drainage;
2. I would make a real tricycle of same length as of our normal cycles and would turn it into a reality.

ACKNOWLEDGEMENT

I, **Bhuwan Agarwal**, student of class IX of **AMITY INTERNATIONAL SCHOOL, VASUNDHARA, GHAZIABAD** would like to thank my principal, **Ms. SUNILA ATHLEY**, my coordinator, **Ms. MEENU MATHUR**, my math teacher, **Mr.BEENA TEWARI**, and all other teachers, for supporting my initiative and guiding me throughout.

I am also thankful to my parents for encouraging and helping me to come up with the idea and its implementation. They have guided me throughout and backed me up in all my attempts.

評語

The mathematical term “inverted catenary surface” is used in the title of the project. This mathematical object is approximated using circular arcs. It appears that the engineering approach to a rigorously defined mathematical surface was dubiously performed. As a science project we suggest the following improvements:

1) A better understanding of inverted catenary surface: This includes (a) an introduction of the concept of “inversion” in plane geometry; an understanding of exponential function which serves as a basis to define the catenary function; (c) an understanding of calculus up to that of rudimental differential geometry.
2) A better understanding of the method of approximation, especially that of osculating circle.
3) A familiarity with the spreadsheet program, such as Excel.