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Research paper

Civil Engineering Tool Kit for Making Perfect Ellipses of Desired Dimensions on Very Large Surfaces

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Abstract

If an ellipse is to be drawn of given dimensions there is no formula, method or set of calculations and procedure available with the help of which we can draw ellipse of given length and width on large ground. Whenever a field engineer is to start the work of an ellipse-shaped structure like elliptical conference hall, screening chamber and pump chamber in disposal work etc. he finds difficulty to give demarcation of the structure on the big surface of the ground. No procedure is available, even in Google. A set of formulas with calculations has been made with the help of which one can draw an true and perfect ellipse of given length and width on the large ground very easily so as to start the construction work of elliptical structure. Based on these formulas a civil Engineering tool kit has been made with the help of which we can make perfect ellipse of desired dimensions on very large surface. The Patent of the tool kit has been filed in Intellectual Property India with Patent Filing Number: 201611026153 and Patent Application Filing Date: 30.07.2016. An App named 'KC's Mesh Formula' has also been made to ease the calculation work. This can be downloaded from Play Store. After adopting these formulas and tool kit, a field engineer will not face difficulty in drawing ellipse on the ground to start the work.

Keywords: *Ellipse; Elliptical Structure; Focus; String; Vertex*

1. Introduction

While giving the marking/nishans of an elliptical shaped structure to be constructed a civil engineer needs to draw an ellipse of required dimensions. He finds difficulty to draw ellipse as no formula or set of calculations and procedure are available. For example during the construction of ellipse-shaped conference hall difficulty is faced during marking demarcation to start the work. Similarly during the construction of disposal work we need to give the marking of under-ground structures like elliptical screening chamber, elliptical pump chamber etc. Important features of an ellipse are shown in Fig. 1 for reference.

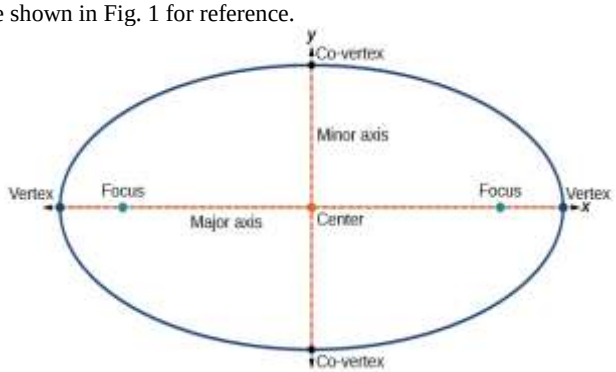

Fig. 1: Ellipse with Nomenclature

For giving the marking of these elliptical shaped underground structures of given length and width we have to draw an ellipse on the ground so as to start the work.

Now-a-days hit and trial method or rough method is used while drawing the ellipse on the ground. Two half circles of diameter equal to width of ellipse are drawn facing each other on the ground and the ends of these semi circles are joined with straight lines. See Fig. 2. This is not true ellipse.

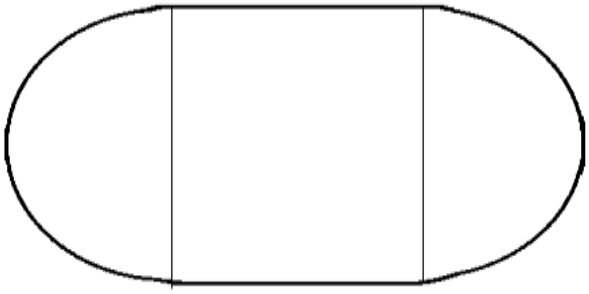

Fig. 2: Hit and Trial Method to Draw Ellipse

A formula and set of calculations & procedure have been prepared with the help of which we can very easily draw true ellipse of any dimensions viz. of any length and breadth.

2. Formulae

Suppose we want to draw an ellipse of length L and breadth B on the ground. For this we require to mark the position of two foci of the ellipse, say C_1 and C_2 (See Fig. 3). Thus the distance of two foci of the ellipse is calculated as under.

Let C is the distance between two foci C_1 and C_2 of the ellipse, then

$$C = \sqrt{L^2 - C^2} \qquad (1)$$

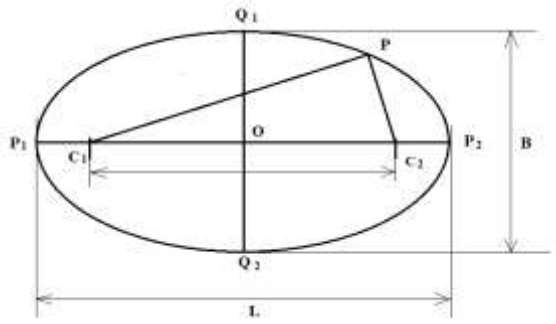

Fig. 3: Procedure of Drawing Ellipse

We require string (dori) of suitable length to draw the ellipse with the help of its two foci C_1 and C_2.

Let L_1 is the length of string to be used, then

L1 = L + C

3. Procedure of Drawing of Ellipse

Fix two pegs C_1 and C_2 on the ground at a distance of C as calculated in (1) above.

Take a string (dori) of length a little more than 'L_1' as calculated in (2) above and tie its both ends together so that after tying the knot the length of string becomes equal to 'L_1'. Stretch the string over the two pegs C_1 and C_2 and also over a movable pointer 'P' as shown in Fig 3. Pull the string taut with the pointer. Keeping the string tight, move the pointer clockwise or anticlockwise on the ground so as to draw the ellipse. Thus the ellipse drawn will be of the desired dimensions.

4. Derivation of Formula

A) <u>To find distance between two foci.</u>

Let L_1 is the length of string

C is the distance between two foci C_1 and C_2

L and B are the length and breadth of the ellipse.

When the pointer 'P' is at co-vertex Q_1, then the string will form an isosceles triangle $Q_1C_1C_2$ See Fig 4.

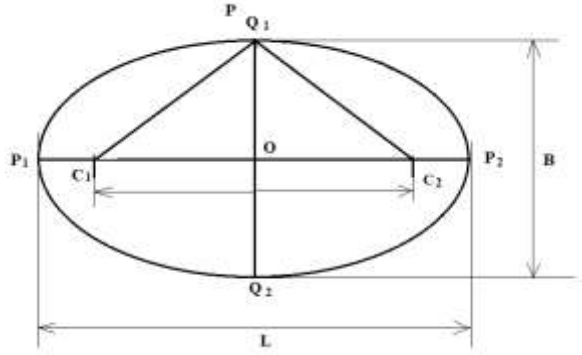

Fig. 4: for Driving the Formula

Then the length of string will be

$$L_1 = Q_1C_1 + C_1C_2 + C_2Q_1$$

$$= \sqrt{[B/2]^2 + [C/2]^2} + C + \sqrt{[B/2]^2 + [C/2]^2}$$

$$= 2\sqrt{[B/2]^2 + [C/2]^2} + C$$

$$= \sqrt{B^2 + C^2} + C \qquad (3)$$

(1)

When the pointer 'P' is at vertex P_2 (See Fig 5), then the length of string will be

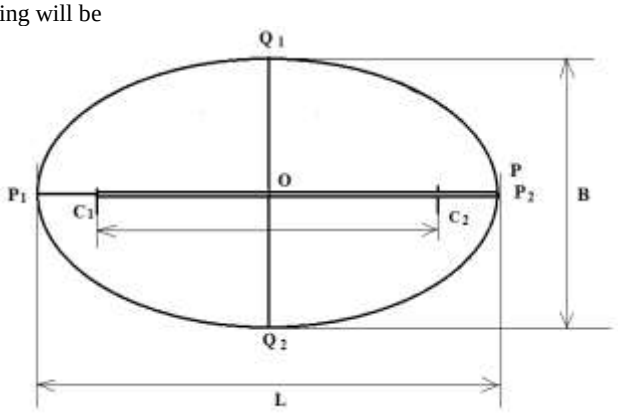

Fig. 5: For Driving the Formula

$$\begin{aligned} L_1 &= 2C_1C_2 + 2C_2P_2 \\ &= P_1C_1 + C_1C_2 + C_1C_2 + C_2P_2 \quad \text{(Because } P_1C_1 = C_2P_2\text{)} \\ &= (P_1C_1 + C_1C_2 + C_1C_2) + C_2P_2 \\ &= L + C \qquad (4) \end{aligned}$$

Equating (3) and (4)

$$\sqrt{B^2 + C^2} + C = L + C$$

$$\sqrt{B^2 + C^2} = L$$

Squaring both sides

$$B^2 + C^2 = L^2$$

$$C^2 = L^2 - B^2$$

$$C = \sqrt{L^2 - B^2}$$

Therefore the distance between two foci will be

$$\sqrt{L^2 - B^2}$$

B) <u>To find the length of string</u>

From (4) above, the length of string L_1 is

$L_1 = L + C$

Once the distance between two foci for inserting the pegs in to the ground and the length of string to be used to draw the ellipse have been calculated, the desired ellipse can be drawn very easily as explained above.

5. Conclusion

Thus for drawing the ellipse on very large ground we can follow the formulae and calculations explained above so as to start the work of elliptical structure. The distance between two foci for inserting the pegs in to the ground and the length of string to be

used to draw the ellipse are calculated, the desired ellipse can be drawn very easily.

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[7] Patent of the invented tool kit has been filed with Intellectual Property India with title as CIVIL ENGINEERING TOOL KIT FOR MAKING PERFECT ELLIPSES OF DESIRED DIMENSIONS ON VERY LARGE SURFACES in the name of KARAM CHAND GUPTA vide PATENT APPLICATION FILING NUMBER: 201611026153 dated 30.07.2016.