ADV MATH SCI JOURNAL
Advances in Mathematics: Scientific Journal **10** (2021), no.1, 29–35
ISSN: 1857-8365 (printed); 1857-8438 (electronic)
https://doi.org/10.37418/amsj.10.1.4 Special Issue on SMS-2020

THE APPLICATION OF CIRCLE EQUATION IN BUILDING COMPOSITE FRONTAGE

HOSSEINALI GHOLAMI[1] AND MOHAMMAD HASSAN ABDUL SATHAR

ABSTRACT. Mathematics is a practical science in human life whereas, mathematicians could provide the answer to many real-world questions of other sciences. In other words, mathematics is a fundamental subject that contributes to other areas such as the technology, engineering and social science. The application of mathematics in other areas of sciences and human life considered as practical mathematics problem. In this article, the researchers introduced a practical problem about building frontage that helps the engineers to frontage some bulging and concave parts of buildings faster, easier, cheaper and higher quality. An arc of a circle is clear and civil engineers need to find the radius of this circle in order to curve the composite sheets exactly the same a circle by using advanced machine. Through discussion about this practical problem, the researchers introduced a mathematics formula that engineers can use it in the similar cases of their works.

1. INTRODUCTION

Mathematical application in the real-world has been found to be strongly related to problem solving skills. Researchers should have relevant knowledge of mathematics concepts and problem solving in order to apply their mathematics knowledge in different areas of human life [1]. It seems that policy makers and educators are more focus on the application of mathematics in the real world during last two decades. According to [2] since 2007, the majority of European

[1]*corresponding author*

2020 *Mathematics Subject Classification.* 97F90, 51E24.

Key words and phrases. Mathematics, Practical Problem, Building Composite Frontage.

countries have revised their mathematics curricula, adopting an outcome-based approach where the focus lies on developing students' competence and skill rather than theoretical content.

The concept of mathematics function is central and practical in many fields of studies to solve the real-world problems [3, 4]. One of the most common applications of functions is modeling the real-world in order to simplify and solve problems [5]. Mathematical knowledge helps researchers to solve the variety of problems in many other fields of everyday life [6]. So practical problem solving is common among the scientists and researchers [7]. Every mathematics problem related to real-world and other subjects is considered as a practical mathematics problem and solving this kind of problems has strongly influence on social daily life activities [8].

In recent years there has been an increasing interest in composites for frontage containing low density and low cost materials [9]. Using composites materials over traditional materials reduces weight, as well as other features such as design flexibility and durability [10]. Researchers found that civil engineers in a building frontage company curved composite sheets based on their experience to frontage bulging or concave parts of a building. Some composite sheets are waste because of more or less curve. Through this method the quality of work for these parts of buildings are not high because there are some waves on the surface of frontage. If engineers have the value of circle's radius that this arc is a part of it; can use an advanced machine and curve the composite sheets exactly. Therefore, not only they can save time, energy and money but also the quality of project increases significantly. Researchers considered an arc of circle with some data and found a formula such as a two variables function to determine the radius of circle.

2. CIRCLE EQUATION

The equation of a circle with center (h, k) and radius r is the form;

$$(x-h)^2 + (y-k)^2 = r^2 \tag{2.1}$$

The theory behind this formula is very simple. The distance of every point on the perimeter of circle to the center is equal to the radius. From Figure 1, the distance formula can be denoted as $\sqrt{((x-h)^2 + (y-k)^2)} = r$ and by squaring both sides we obtain the circle equation as $(x-h)^2 + (y-k)^2 = r^2$. If we have at least 3 points of a circle perimeter then the equation of circle is clear by several

different solutions such as using circle equation formula or using the following theorem: Theorem: The three perpendicular bisectors of the sides of a triangle are concurrent (which means that they intersect at one point).

3. STATEMENT OF THE PROBLEM

Some buildings like Figures 2 and 3 have convex or concave structures/frontage, the frontage of these parts of buildings with composite sheets based on experience face difficulties such as more time, more expenses and less quality. In fact, an arc of a circle is given so if engineers have the radius of this circle then they can curve the composite sheets exactly the same circle by using advanced machine.

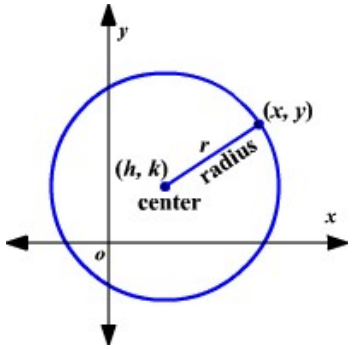

FIGURE 1. The theory behind the circle equation

FIGURE 2. Building with concave part

FIGURE 3. Building with bulging part

4. RESULTS

4.1. **DESCRIPTION OF PROBLEM SOLVING.** First, researchers considered a graph for this practical problem as follows:

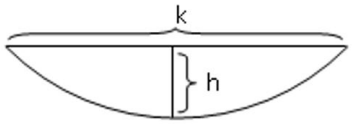

FIGURE 4. A design of practical mathematics problem

It is clear that the two lengths denoted by h and k are measurable. After that the above graph transformed on coordinate axes (Figure 5) therefore, the following information are clear about a circle. In fact, three points,$A(\frac{-k}{2},h)$, $B(0,0)$ and $C(\frac{k}{2},h)$ are on the perimeter of a circle. We need to find the radius value of this circle. Two different solutions suggested For this practical problem as follows:

Solution I:

We put the coordinate of three points A, B and C in the circle equation formula (2.1) to find the following three equations

$$(-\frac{k}{2}-\alpha)^2+(h-\beta)^2=R^2, \tag{4.1}$$
$$(0-\alpha)^2+(0-\beta)^2=R^2,$$

$$\left(\frac{k}{2}-\alpha\right)^2+(h-\beta)^2=R^2. \tag{4.2}$$

Based on the above equations, researchers were obtained the following formula to calculate the radius of the circle.

$$R=\frac{k^2+4h^2}{8h}.$$

In fact, this formula is a function with two variables h and k that civil engineers can measure the values of these variables and find the value of the radius by the following function:

$$R(k,h)=\frac{k^2+4h^2}{8h}.$$

Also we can put just center coordinate of circle in the equations (4.1) or (4.2) to find this relation.

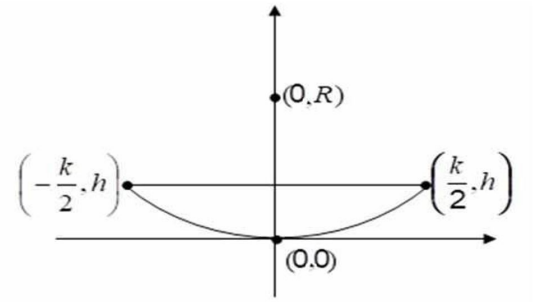

FIGURE 5. A design of practical mathematics problem on coordinate axes

Solution II:

In the triangle ABC, three perpendicular bisectors of sides cut each other on the center of circle. Therefore, we need to find just perpendicular equation for AB (m_{AB} is the slope of AB).

$$m_{AB}=\frac{y_A-y_B}{x_A-x_B}=\frac{-2h}{k},$$

$$y-\frac{h}{2}=\frac{k}{2h}(x+\frac{k}{4})\Rightarrow y=\frac{k}{2h}x+\frac{k^2+4h^2}{8h},$$

$$x=0\Rightarrow y=\frac{k^2+4h^2}{8h}\Rightarrow R=\frac{k^2+4h^2}{8h}.$$

We can apply this formula in similar cases. For example, some lands are located in the marginal of squares such as Figure 6, so the area of this land calculates by the formula $R = \frac{k^2+4h^2}{8h}$.

If this arc is exactly a quarter of circle perimeter then we have:

$$S_{land} = S_{rectangel} - (\frac{1}{4}\pi R^2 - \frac{1}{2}R^2),$$

On the other hand, we can find the area of land easily, by trigonometric concepts.

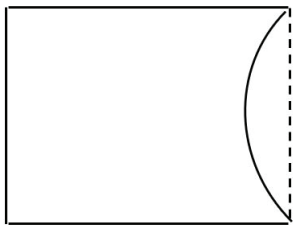

FIGURE 6. A picture of a land located around a square

5. CONCLUSIONS

This practical problem shows an application of mathematics in the real world. Everybody needs to learn problem solving skills in general, because there are a lot of problems in our life that we must solve them in the best way. In fact, mathematics is the life science; it helps us to improve our mind for better life. Mathematics problem solving skills increase the ability and creativity of people to solve their social problems through better ways.

Through traditional method, sometimes engineers curve the composite sheets more or less so the quality of work is low because there are some waves on the building frontage. Based on the mathematical formula that discussed in this article, civil engineers can find the radius of circle for some bulging or concave parts of buildings. So they can curve the composite sheets exactly by advanced machine and improve the quality of composite frontage. In fact, the result of this article helps engineers to find the radius of circle for similar cases and curve the composite sheets such that there is no waves on the surface of bulging or concave parts of buildings frontage.

6. Acknowledgment

This research was supported by University Putra Malaysia (UPM) under its short-term grant Putra Muda (GP-IPM/9589600) scheme.

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Institute of Mathematical Research
University Putra Malaysia, 43400 Serdang, Selangor, Malaysia.
Email address: hossein_gholami52@yahoo.com

Centre of Foundation Studies for Agricultural Science
University Putra Malaysia, 43400 Serdang, Selangor, Malaysia.
Email address: mohdhasan@upm.edu.my