Department of Mechanical Engineering

MUH 104 - An Introduction to Mechanical Engineering

Mouse Trap Axle Systems

by

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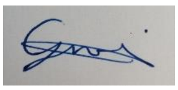
I confirm that I have followed the Academic Integrity Rules.



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Abstract

In this report, we will examine the ideal wheel-axle combination models for the Mousetrap Mechanism. Firstly, this mechanism is a tool that works with a mouse trap. The working principle is the process of the axle rotating the wheels by transmitting the spring tension force to the axle. The optimum connection between the axle and the discs increases the characteristics of the produced vehicle such as longer range and longer travel time. In this report, we will examine three types of connection models and talk about the advantages and disadvantages of these models.

1.Introduction

The mousetrap car is a mechanism that uses many physical effects together, which has been produced by many engineer candidates and high school students for many years. The aim is to convert the energy in the compressed spring into rotational energy through the wheels and axle. Competitions in various categories have been held many times. In these competitions, they were scored by factors such as the vehicle's general structure, lightness, road distance, time on the road, ease of production, cost, and appearance. In this report, we will score our three designs with these factors and find the optimum design.

2. Mousetrap car axle-wheel designs

First of all, we have to use two 1.25 mm thick discs with an outer diameter of 120 mm and an inner diameter of 15 mm and an axle of 5 mm thickness. Without changing these structures, we developed three designs. In the first design, we used a screw and a perforated nut. In the second design, we used wood and roller bearings. In the third design, we used cylindrical rubber with holes. In these designs, toothless and steel axles are used as in Figure 2.1 Steel Axle. Let's examine these designs one by one.

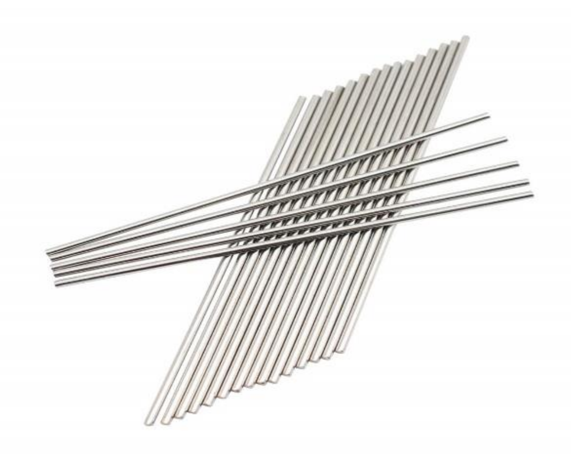


Figure 2.1 Steel Axle

2.1 Axle-Wheel 1st Design

In this design, screw holes must be drilled into the discs as shown in Figure2.2 Axle-Wheel Design-1. Two perforated aluminum washers are used for a disc as shown in Figure 2.3 Perforated Nut. On both sides, the square screws in Figure 2.4 Square Screw should fix the disc with nuts. The design is then completed by passing the axle through the nuts.

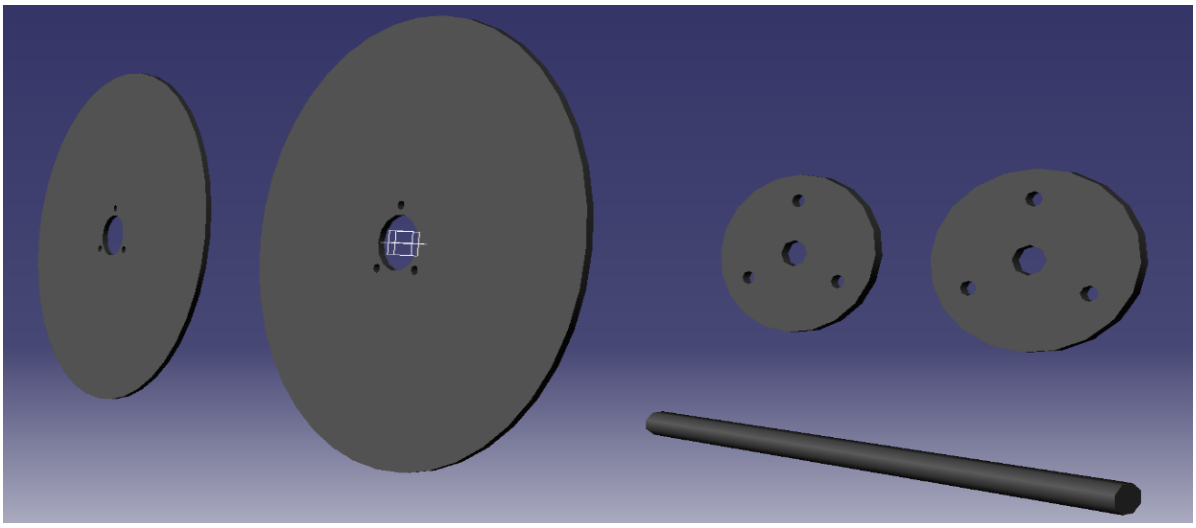


Figure 2.2 Axle-Wheel Design-1

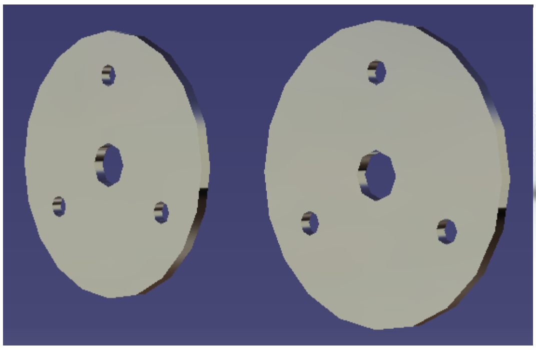


Figure 2.3 Perforated Nut

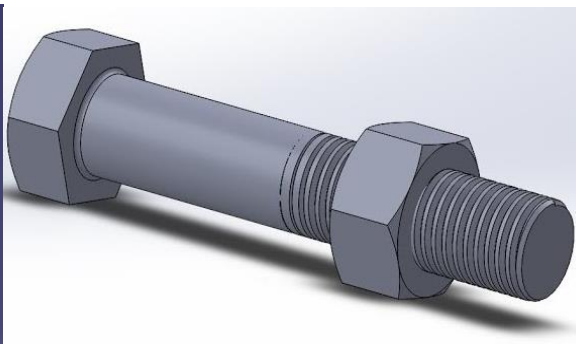


Figure 2.4 Square Screw

The dimensions of the perforated nut, square screw and the holes of the disc used in the 1st design are given in Appendix-1. Catia drawing of this design is at Link.1.

[https://drive.google.com/file/d/1GPBzji_iMcFoDKYWykrm4oaO01MPdiYF/view?usp=sharing] **Link.1**

2.2 Axle-Wheel 2nd Design

In this design, there is no need to perform any action on the discs as shown in Figure 2.5 Axle-Wheel Design-2. In this design, two perforated wooden plates as in Figure 2.6 Perforated Board and a roller bearing as in Figure 2.7 Roller Bearings are required for a disc. The wooden plates are glued concentrically with the discs. The bonding process should be done using industrial plastic-wood adhesive. Then, as the required thickness is reached, the bearing should be placed in the center in the middle of the disc and the boards. Finally, the design is completed by passing the axle through the bearing.

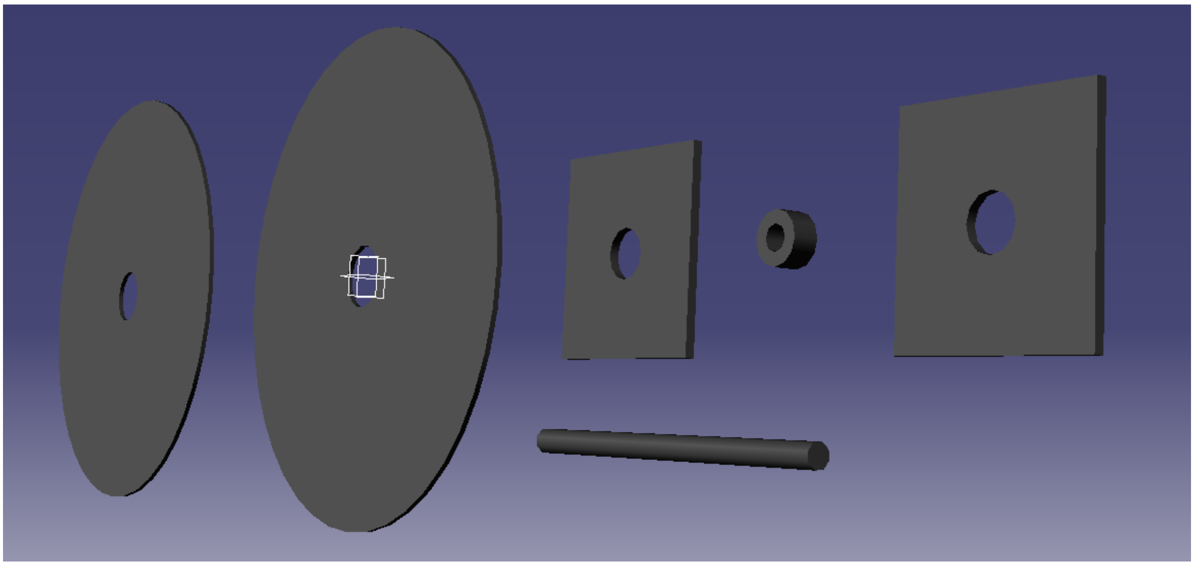


Figure 2.5 Axle-Wheel Design-2

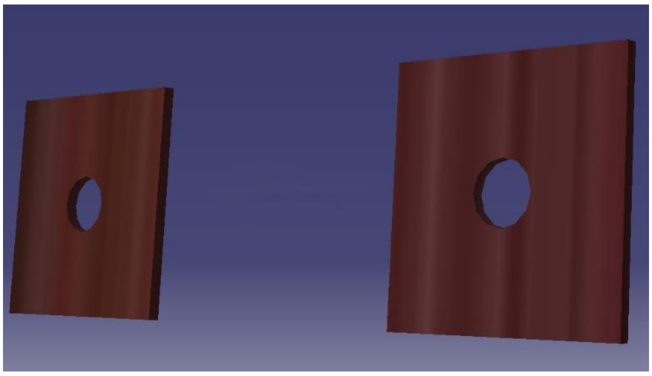


Figure 2.6 Perforated Board

Figure 2.7 Roller Bearings

The dimensions of the boards and bearing used in the second design are in Appendix-2. Catia drawing of this design is at Link.2.

[https://drive.google.com/file/d/1YFvV6aLQJ7EEp9NlMPQ_Juc7MgB9x--c/view?usp=sharing]**Link.2**

2.3 Axle-Wheel 3rd Design

In this design, there is no need to perform any action on the discs as shown in Figure 2.8 Axle-Wheel Design-3. This design is a very practical and lower cost design as long as there is rubber material in the required dimensions. For one disc, one piece of rubber shown in Figure 2.9 Rubber Roller is used. It is benefited from the flexibility and compressibility of the rubber material. The rubber part must first be attached to the disk by a compression process. Finally, the design should be completed by placing the axle on the rubber part by stretching method.

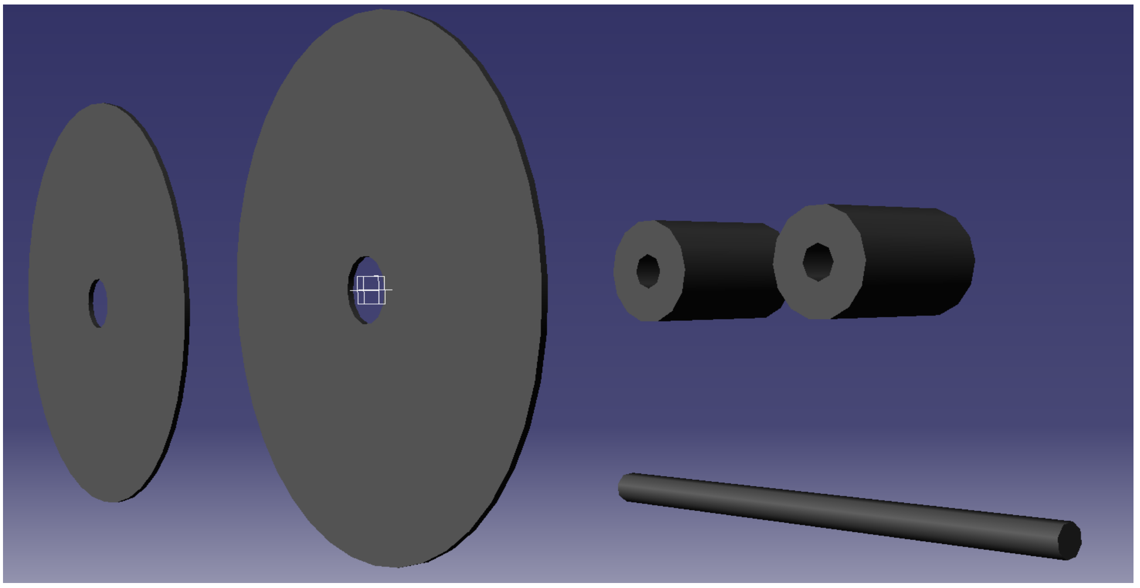


Figure 2.8 Axle-Wheel Design-3

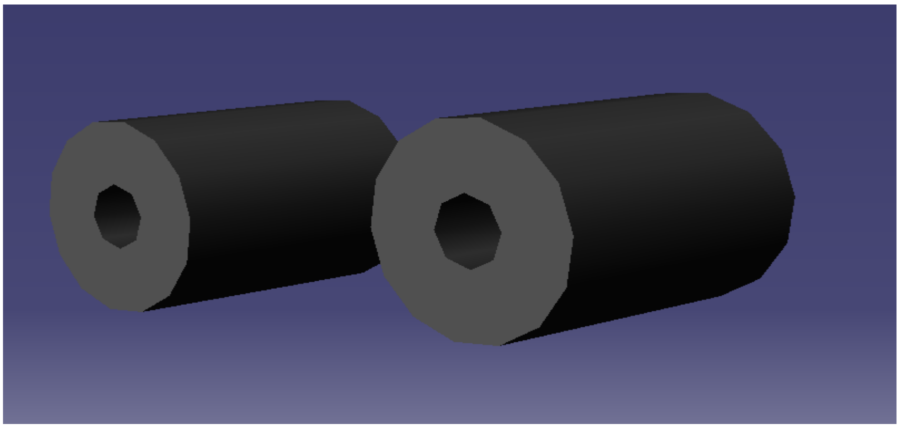


Figure 2.9 Rubber Roller

The dimensions of the rubber part used in the 3rd design are given in Appendix-3. Catia drawing of this design is at Link.3.

[https://drive.google.com/file/d/1efgAwkv7v5Tqow4Sa4mvuSTFlN-bN1UB/view?usp=sharing]**Link.3**

2.4 Choosing the Ideal Design

We have to define a few criteria to choose the most optimum design. These criteria are low cost, ease of production, appearance(aesthetic) and energy efficiency(performance). Let's evaluate for three designs respectively.

2.4.1 Lower Costs

Cost is always an important factor for manufacturing. In these three designs, it is more costly to produce the perforated nut in desired dimensions compared to other designs. The bearing used in the second design is more costly than rubber. In this criterion, our choice is the 3rd design.

2.4.2 Ease of Production

Practical production of a product will provide convenience in disassembly and assembly processes during the manufacturing process. In the 1st Design, there is a screwing process and a hole in the disc in desired sizes, so the 1st design is in the last place in this criterion. There is no sticking or screwing process in the 3rd design. The design is completed only with compression and stretching processes, so the 3rd design is in the first place in this criterion.

2.4.3 Aesthetic

The concept of aesthetics is very valuable even in the smallest parts produced today and adds a lot of value to the product. 3. A rubber that is black in design and deformed during production is non-aesthetic. In the second design, the pieces of wood affixed to the discs are also non-aesthetic. Therefore, 3rd design and 2nd design share the last place in this criterion. 1st design, on the other hand, gives the appearance of an industrial production and is very aesthetic, so 1st design takes the first place in this criterion.

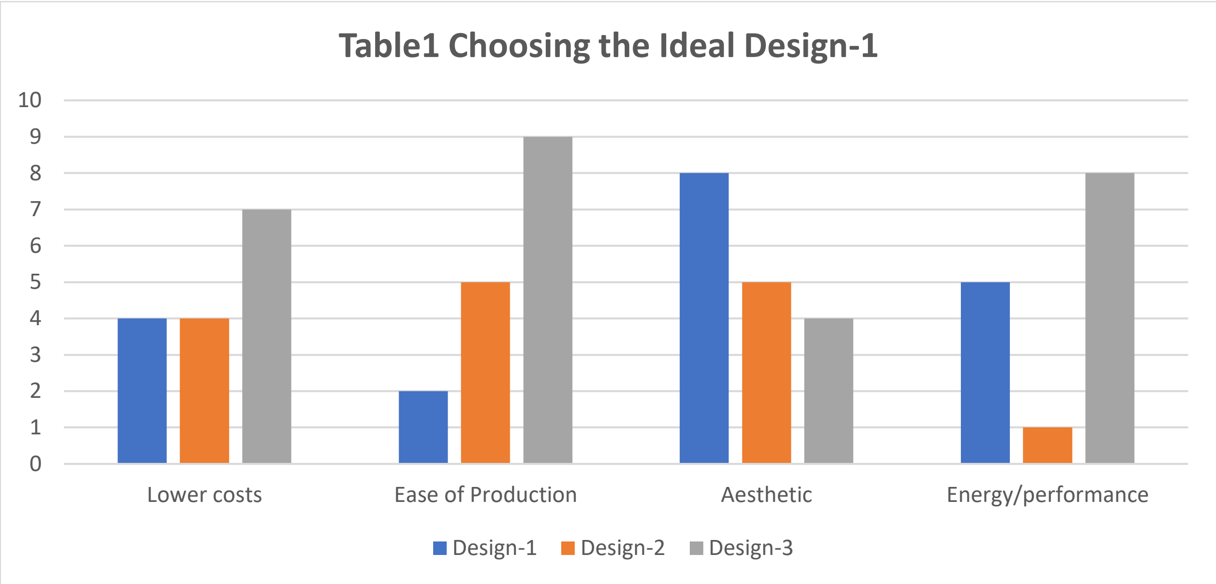
2.4.4 Energy/performance

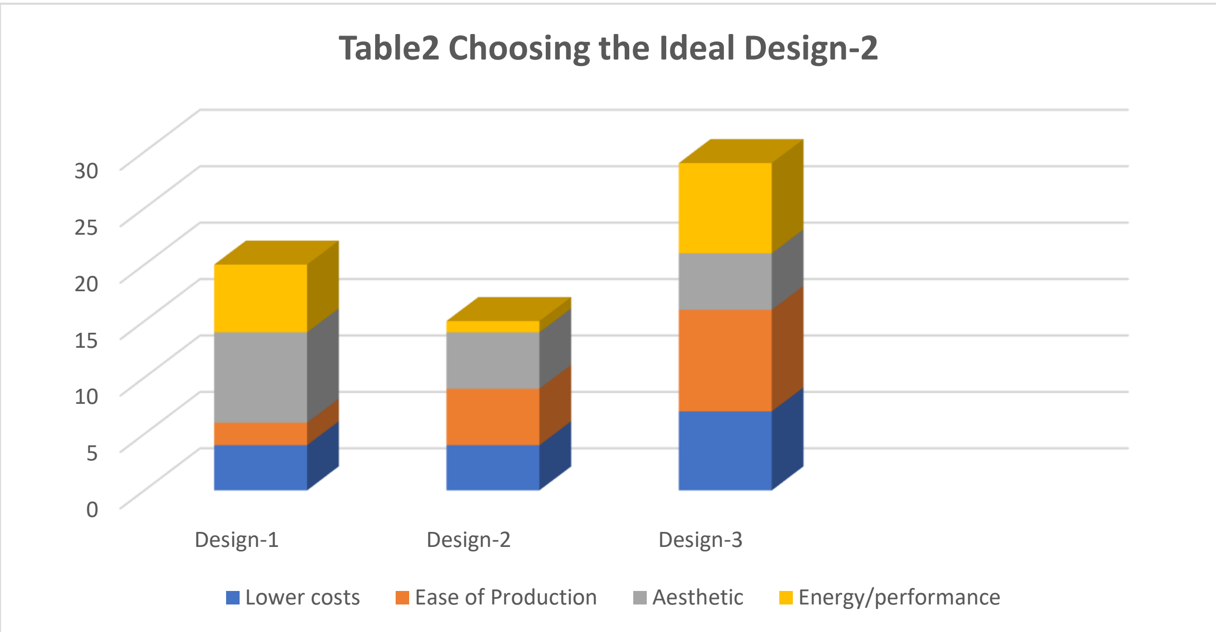
Energy is the most important criterion for a mousetrap car because it takes into account the distance the mousetrap car travels in many competitions and shows. In order to increase the road distance, the energy stored in the spring should be transmitted to the disk with as little loss as possible. In the 2nd design, all the rotational energy of the axle is consumed in the marbles inside the bearing and very little is transmitted to the wheels, so the 2nd design is the last in this criterion. In 1st design , energy is lost as we place the axle directly over the common diameter perforated nut, so 1st design is second in this criterion. Although the rubber deforms in the long term in the 3rd design, the stability (connection) provided by the compression transmits the energy quite a lot, so the 3rd design is the first in this criterion.

3. Conclusion

We did the reviews for the mousetrap vehicle. We scored these criteria as they appear in Table1 Choosing the Ideal Design-1 and created a stack chart as shown in Table2 Choosing the Ideal Design-2. Finally, although it does not have an aesthetic design, the most optimum design is the 3rd Design. In this design, if the required cylinder rubber is found, a highly efficient, easy and inexpensive mousetrap vehicle can be produced.

The worst choice according to the criteria will be the 2nd Design because the bearing used absorbs energy rather than transmitting it, resulting in a very bad design.





4. Appendices

4.1 Appendix-1

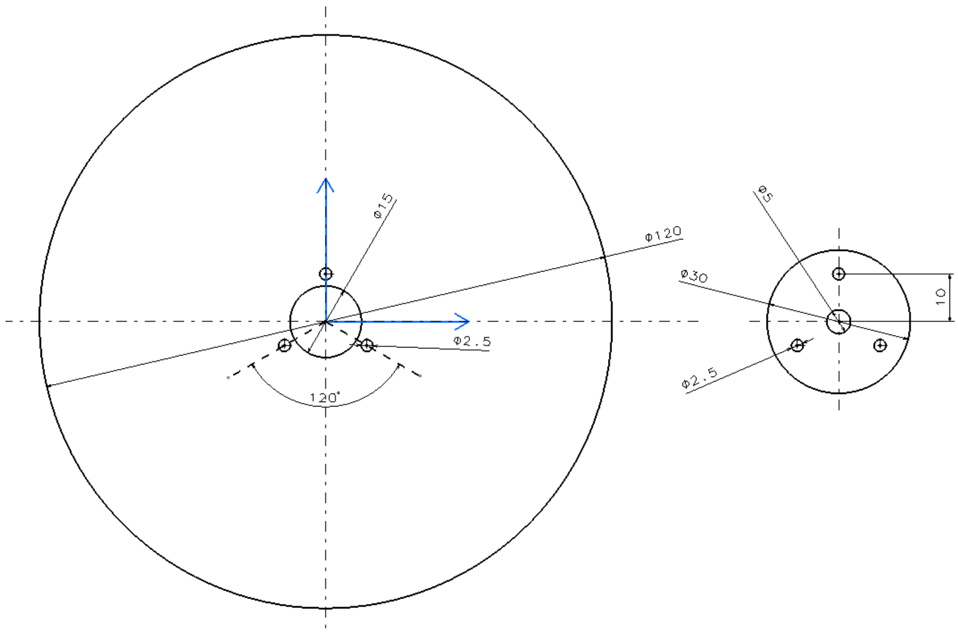


Figure 4.1 Axle-Wheel Technical Information-1

Square screw is 2.5mm in diameter. 6 screws are used in the design.

The thickness of the nut is insignificant. 4 nuts are used in the design.

The size of the square screw can vary with the thickness of the nut.

4.2 Appendix-2

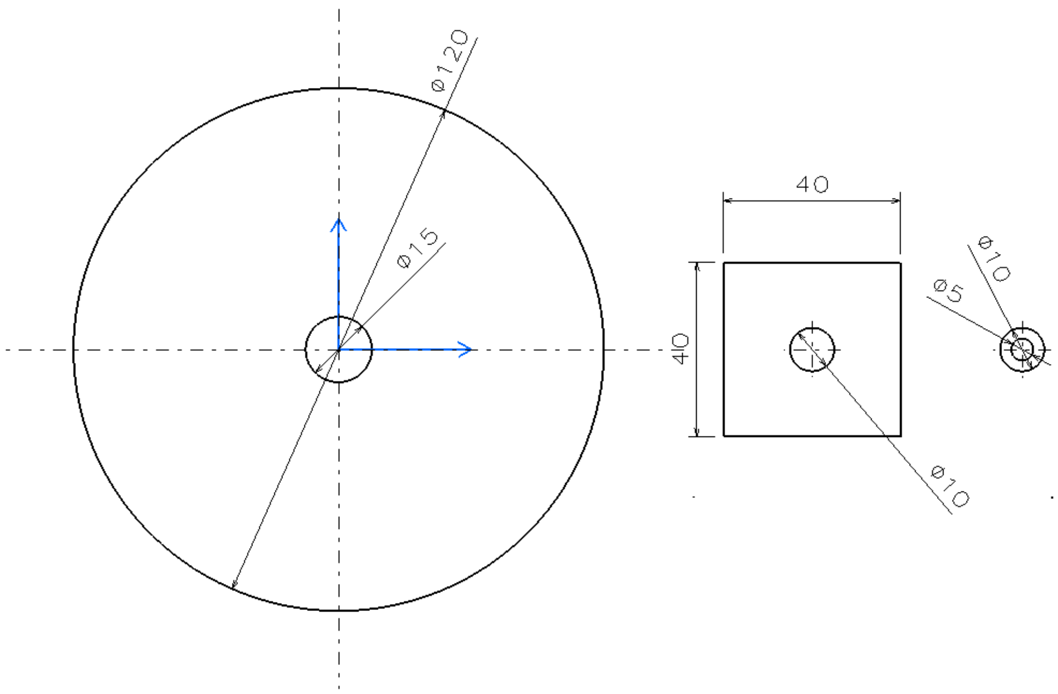


Figure 4.2 Axle-Wheel Technical Information-2

The thickness of the boards is 1.875mm. 4 boards are used in the design.

The thickness of the roller bearing is 5mm. 2 bearings are used in the design.

4.3 Appendix-3

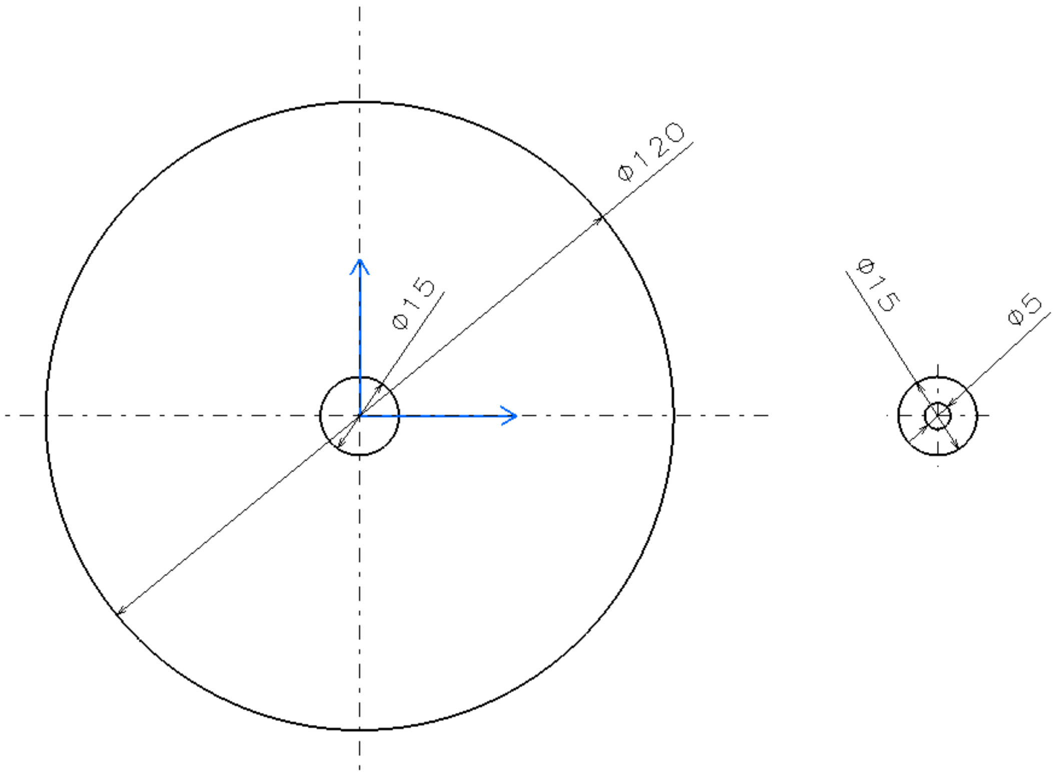


Figure 4.3 Axle-Wheel Technical Information-3

The thickness of the rubber is 20 mm. 2 rubber cylinders are used in the design.