

The Design And Responses Of Horses On Polimeric Composite Horseshoes

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Abstract. Horseshoe is used to avoid the failures of horse's hooves due to extreme impact and wear loads. The horse's hooves are repeatedly subjected to loadings during walking, trotting, running and jumping. In this research, we introduce a newly developed horseshoes made of polymeric composite materials. The horseshoes are placed inside the leather boot; it is a specially designed for horse. The process of making horseshoes and horse boots were discussed and the responses of the horse shoes as well as horses were analyzed. The horses were subjected to a series of testing, e.g., walking, trotting, and running. The result of the tests indicate that horseshoes and horse boots are quite strong, light, and safe to be used on horses. The response of horses shows that the horseshoe and boots are quite comfortable for them. This can be seen because there are no significant behavioral changes of the horse before and after wearing the boot. After being used to, it was shown that there is no damage or crack of the horseshoe. Therefore, it can be concluded that the composite horseshoe is safe and good to be used as horseshoe material.

Keyword: Fiberglass, Horse responses, Polymeric composite horseshoe, horse boot.

Abstrak. Tapal kuda digunakan untuk menghindari kegagalan tapal kuda akibat benturan keras dan beban keausan. kuku kuda berulang kali dikenakan beban saat berjalan, berlari kecil, berlari cepat dan melompat. Dalam penelitian ini, kami memperkenalkan tapal kuda yang baru dikembangkan yang terbuat dari bahan komposit polimer. tapal kuda ditempatkan di dalam sepatu boots kulit, yang dirancang khusus untuk kuda. Proses pembuatan tapal kuda dan sepatu bot kuda dibahas dan respon dari sepatu dan kuda dianalisa. Kuda-kuda tersebut menjalani serangkaian pengujian, misalnya, berjalan, berlari kecil, dan berlari cepat. Hasil pengujian menunjukkan bahwa tapal kuda dan sepatu boots kuda cukup kuat, ringan, dan aman untuk digunakan pada kuda. respon kuda menunjukkan bahwa tapal kuda dan sepatu boots cukup nyaman untuk mereka; Hal ini terlihat karena tidak ada perubahan perilaku yang signifikan pada kuda sebelum dan sesudah memakai sepatu boots. Setelah digunakan secara lama tidak ada kerusakan atau retak pada tapal kuda, oleh karena itu dapat disimpulkan bahwa tapal kuda komposit ini aman dan baik untuk digunakan sebagai material tapal kuda.

Kata Kunci: Fiberglass, Polymeric resin, Sepatu kuda polymeric composite, boots kuda.

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1. Introduction

Horseshoe is functioned to protect horse's hooves against blows and extreme wear caused by contact with the ground [1]. Horseshoes are usually made of iron/steel with the size suitable to place underneath the horse's nail/hooves [2]. A typical steel-made horseshoes is shown in Figure 1. The use of conventional horseshoe may deteriorate the hooves caused by nails which is in practice directly nailed to the hooves. Thus horseshoes made of alternative materials such as plastic and suitable for horse racing [3] and polymeric composites have been developed [4] [5] [6].



Figure 1 Steel-made horseshoe [2]

In our research center, the research on composite horseshoe was conducted on three research topics, i.e., experimental tests to determine the strength value of the specimen, both in tensile and bending strength. For this research the horseshoe materials are made of polymeric resin reinforced with fiberglass. It was found that the 2-layered specimen had a better mechanical response value [6]. The next group carried out static simulation that occurred in the horseshoe using FEM commercial software which could be seen that the composition of horseshoe with two layers of fiberglass had a higher maximum stress value than that of one layered fiberglass. A qualitative study conducted through a survey whether horses are likely to enjoy the steel shoes nailed to their hooves shows that 7% of horses do not like steel shoes [7]. The surveyor admits that perhaps it is not totally scientific, however with a decent sample size and observed directly by the owner (research informant), it may lead us to further study. The study may leave more questions, e.g. , do they also dislike wearing boots, or glue on shoes? This comes to a point that a further study on how horses react on this newly designed horseshoe and boot are needed.

Thus, in this study, the horseshoe is manufactured using the material BTQN 157 EX resin reinforced with fiberglass. The horseshoe is designed slightly higher to cover the horse's feet. The blowing agent material is not used to obtain a solid structure. We insert polymeric horseshoe in leather boots; then they are installed to horse hooves by shoe laces. No single nails were used! After experimental and simulation tests using Ansys software [6], the horseshoe and boot were put on the horse's hooves to determine the strength of the horseshoe and responses of the horse towards the horseshoes.

2. Material and Method

2.1. Material, Geometry, and Dimensions

Generally, the horseshoes as shown in Figure 1 are attached by nailing them to the horse's hooves. But in this study, the steel horseshoes were replaced with lighter, corrosion-resistant, and stronger materials i.e., polymeric resin reinforced with fiberglass. The installation is not done by nailing but instead is wrapped and inserted into the boots of the horseshoe which is designed in such a way made of leather and attached by tying the shoelaces.

Design of horseshoe and boots resulted from anthropometric study can be seen in Figure 2(a). As shown in the figure, the polymeric horseshoe is designed with a thickness of 13.325mm. It is located in between the rubber soles and pad of the horse's boots. Both are of 7mm thick which are to be covered by leather as shown in figure 2(c).

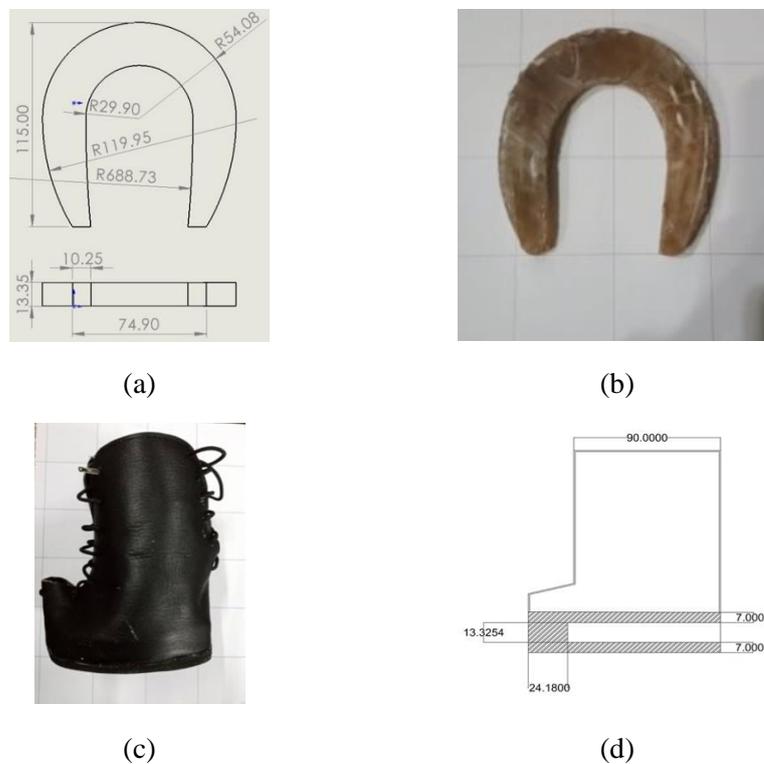


Figure 2 Horseshoe

(a) Design of polymeric shoe (b) Polymeric Horseshoe (c) Boots with leather material (d) cross-sectional view of horseshoe in boot

3. Research Method

Design of the horse shoes were conducted using solid work incorporating results obtained through anthropometric study of the hooves. The horse shoes were simulated using ANSYS software [6]. The production of horseshoe are done after testing the strength of the material and Ansys simulation in the laboratory. The results of the horseshoe test are carried out by applying it directly to the horse as shown in Figure 2 (d) which will then the response to the horses to be observed. The method of making one-layered polymeric horseshoes specimen is as follows:

- Apply wax to the inner wall of the mold in order to make it easier to open the product when it dries.
- Pour BTQN 157 EX resin on a measuring cup and preparing MEKPO catalyst which is 1% of the total resin volume.
- Mix and stir gently to avoid air bubbles until it smoothens.
- Pour half the mixture of BTQN 157 EX resin and MEKPO catalyst into the mold.
- Place the fiberglass that has been cut into the shape of the mold on a mixture of BTQN 157 EX resin and MEKPO catalyst, then pressed in such a way that it is evenly distributed.
- Pour the remaining mixture of BTQN 157 EX resin and MEKPO catalyst over the fiberglass.
- Flatten and tightly closed with a lid until the specified time.

The manufacture of two-layered horseshoe specimens includes the following steps:

- Apply wax to the inner wall of the mold in order to make it easier to open the product when it dries.
- Pouring BTQN 157 EX resin in a measuring cup and preparing MEKPO catalyst which is 1% of the total resin volume.
- Mix and stir gently to avoid air bubbles until smooth.
- Pour 1/3 (one third) of the mixture of BTQN 157 EX resin and MEKPO catalyst into the mold.
- Place the fiberglass that has been cut according to the shape of the mold on a mixture of BTQN 157 EX resin and MEKPO catalyst, then pressed in such a way that it is evenly distributed.
- Pour 1/3 (third) of the mixture of BTQN 157 EX resin and MEKPO catalyst over the fiberglass.
- Put another fiberglass that has been cut according to the shape of the mold then pressed and flattened in such a way that it is evenly distributed.
- Pour the remaining mixture of BTQN 157 EX resin and MEKPO catalyst over the fiberglass.
- Flatten and then tightly closed with a lid until the specified time.

Horseshoes were also tested under free fall impact test to observe the strength of specimen. Qualitative check on crack or damages that may occur during free fall impact test from the height of 1 meter, 2 meters and 3 meters.

After the boots are produced, the boots are applied directly to the horse legs which continued to the next research which is observing the response of the horse toward the horseshoe. In which responses are usually observed and analyzed by the behavioral changes of the horse before, during, and after the test are done. The tests are to include walking, trotting and ambling. Galloping test are not included in this study due to the limited field space and the health of the horse. The horse used in this test had approximate height of 1.3 m and weight of approximately 200kg.

4. Results and Discussions

In our previous researches we have reported that polymer reinforced by fiberglass horseshoe can be used as an alternative to steel-based horseshoes [3,4]. The horseshoes were made by hand lay-up method with BTQN 157 EX resin reinforced with fiberglass. MEKPO catalyst was used to accelerate the formation of the structure. The horseshoe that is formed are then wrapped in a cowhide boots/cover with rubber pad and soles, the shoelaces used are wool materialled, as generally used on humans. Pictures of horseshoe and boot's footwear can be seen in Figure 3.

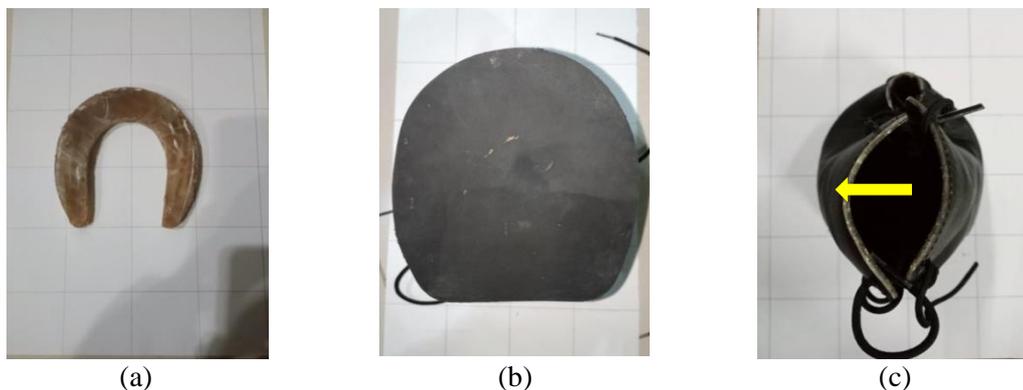


Figure 3 (a) Horseshoe (b) Horseshoe boots' sole (c) Horseshoe pad inside the boots

Horseshoe testing is carried out after the horseshoe is formed which is tested by applying it directly to the horse and analyst the response of horse to the horseshoes. The progress and behavior of horses when wearing horseshoes can be explained below:

- In the first two minutes, when performing normal walking movement, it can be seen that the movement of the horse's legs looks like it is lifted because the horse needs adjustment after use.
- After adjustment, the horse can walk normally (walk) and walk quickly (trot).
- 10 minutes after walking briskly, without realizing it can jog (amble/canter). Therefore, the horse can be tested for amble, trot and walk.

Unfortunately, gallops test result is not available due to the limitations of the field and the health of the horse. Therefore, the horseshoe test was discontinued until the horse's movement was amble/canter. The picture of applying horseshoe and the horse while performing a walking movement can be seen in Figure 4.



Figure 4 (a) Applying Horseshoe (b) Horse's walking movement

In this test it can be seen that the horse is quite comfortable with this polymeric composite horseshoe. This can be seen because there are no behavioral changes of the horse that occurs before and after use, it's just that when doing the walking movement, the horse needs time to adjust to the horseshoe. Report in form of video has been uploaded to bustamisyam YouTube channel (<https://youtu.be/9y-2M6AKp3g>). It was found that the horseshoe had no signs of damage or cracks, and when compared to the free fall impact test at a height of 3 meters, the specimen also did not suffer any damage or cracks. So, it can be concluded that the polymeric horseshoe material reinforced with fiberglass is strong enough to be used as a horseshoe material [5].

5. Conclusion

Horseshoes and boots have been designed, manufactured, tested, simulated in our laboratory. The results of this test indicate that horseshoes and boots are quite strong, light, and safe to be put on horses. The horse's response shows that the horseshoe is quite comfortable to wear, this can be seen because there are no behavioral changes of the horse from before and after wearing the horseshoe, it just takes time for the horse to adjust to the horseshoe during walking. After being used for walking and running, there is no damage or cracking of the horseshoe, therefore it can be concluded that this composite horseshoe is safe and good to use as horseshoe material. Further study in other fields tests are recommended.

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