

Cushioning Packaging Design of the Colored Ceramic Horse

Jingrui Cai

College of Materials Science and Technology, Beijing Forestry University eBeijing, China

Email: jruicai@163.com

Abstract: Ceramic artworks became more and more popular in both China and foreign country for their strong, durable, attractive features. But the current packaging of them was mainly simple polystyrene foam with lower costs. However, because of poor quality materials and not environmentally friendly, this kind of transport packages was only suitable for low-grade products. This article made improvement in the current plastic foam packaging of the colored ceramic horse. With the test results and the analysis of the characteristics of the product, we chose three kind of flute corrugated cardboard pad (A、B、C) as the new buffer. Besides, two reasonable schemes were designed, one put emphasis on cushion capacity, the other on lower cost. After that, experimental programs were designed to verify the effects of the buffer and compare the two schemes. Taking all those into consideration, it was including protection function, environment-protection, low-cost, attraction, artistic value and other factors, we got a optimal combination: cushioning pad was made of B flute corrugated cardboard, outer packaging box was made of E flute corrugated cardboard, so the second scheme was the cushion pad structure. The materials totally cost 0.1 yuan more than that of the current plastic foam packaging.

Keywords: ceramic artworks; cushion pad; corrugated cardboard; drop test; cost analysis

1. Introduction

Ceramic artworks are spiced with primitive simplicity, refreshing, naturalness and they are ornamental, collecting as well as practical. Observing ceramic artworks, people have the thought-provoking feeling from fire and mud molding. Because ceramic artworks are very delicate and easily damaged in the process of transportation, loading and discharging, so cushion packaging is the very important link for ceramic artworks in the process [1].

The current packaging of ceramic artworks was mainly simple polystyrene foam with lower costs. However, because of poor quality materials and not environmentally friendly, this kind of transport packages was only suitable for low-grade products and effected the market. Folding corrugated cardboard had good compression performance and buffer performance, and it could be printed with various patterns, signs, etc, according to the needs of the enterprises, so it had the function of sales promotion. Although the cost of individual packaging, compared with the plastic packaging, was without remarkable advantage, the overall cost was much lower than that of foam packaging. In addition, both internal and external use of corrugated cardboard, could be environmentally protected and easily recycle, upgrade products, as well. At present, corrugated cardboard would be the best choice for ceramic artworks.

This article studied on the Cushioning Packaging of the colored ceramic horse. Using environmentally friendly corrugated cardboard superseding plastic foam, the cushioning material was designed to satisfy the

transport needs of the colored ceramic horse. The design method should apply to the ceramic artworks packaging.

2. The Capability and Current Package of the Colored Ceramic Horse

The colored ceramic horse was very delicate with 1kg gross weight, and its basic dimension (length \times width \times high) was 250mm \times 90mm \times 245mm. The horse center of mass nearly was the geometric center, the middle of the horse abdomen. The horse had four spindlelegs and three legs were touchdown, one leg was flexural with hanging in the air and the head rose from side. According to the horse figure, the extremely fragile position was the legs, tail and head.

Now the cushioning material used in the colored ceramic was the polystyrene foam. The foamy structure was flatwise put with two blocks clamping the horse. On the basis of the horse shape, the foam was molded (Fig.1). The size of upper cover was 280mm \times 275mm \times 70mm, while the lower cover 280mm \times 275mm \times 45mm. This package could protected the horse, but the quality of the foam was poor, because when drawing out the foam there were many foam debris and the cushion was often destroyed. So the current package was not environmentally friendly and degraded the product.

3. Design the Cushioning Package of the Colored Ceramic Horse

3.1. How to Design

According to the structure of the colored ceramic horse, the legs, tail and head were substantial to be design to protect them. There were two packaging schemes: first scheme aimed the cushioned package; based on first scheme, second one was took cost into account by reducing the amount of the corrugated cardboard, there were many difference on the size of the support and the structure of the part. At last design prototypes and test the two schemes to choose the oriental one.



Figure 1. The current cushioning pad of the colored ceramic horse

3.2. Select the Package Material

Selected single wall corrugated cardboard by A-, C- and B-flute, corresponding all thickness were 4.5cm, 4cm, 3cm and weight were 175g/m², 175g/m², 110g/m². Outer packaging box was made of E-flute corrugated cardboard, with 2cm thickness.

3.3. First Scheme

In the first scheme there were three points supporting the horse's neck and two legs, other parts including ears, mouth, another two legs and tail were design hung in the air. There was a layer of cushion between the ear and the outer packaging box. Another two legs were slightly under the highest plane of the cushion hung in the air and the tail was 3cm distant from the side board hung in the air. The folding cushion was the three layer structure.(Fig.1 and Fig.2).

On the scheme 1, the size of the cushion molded was: 280×260×112mm³.

According to the dimension of the horse,
(7)=15mm, (8)=(13)=90mm, (10)=(11)=28mm,
(12)=80mm, (14)=95mm,

$$\begin{aligned} \text{So } (9) &= 260 - t - (7) - (12) - (14) - 30 = 40 - t, \\ (6) &= (15) = 112 - t, \\ (5) &= (16) = (260 - 2t) / 2 = 130 - t, \\ (4) &= (17) = (6) - (8) - t = 22 - t, \\ (2) &= (19) = (4) - t = 22 - 2t, \\ (3) &= (18) = (5) - t = 130 - 2t, \\ (1) &= (20) = (\sqrt{(2)^2 + (3)^2}) - 1.5t. \end{aligned}$$

When A-flute corrugated cardboard was selected, $t=4.5\text{mm}$, then substituting the formula, the size of all cardboard used was $1450.5 \times 280\text{mm}^2$.

When B-flute corrugated cardboard was selected, $t=4\text{mm}$, then substituting the formula, the size of all cardboard used was $1487 \times 280\text{mm}^2$.

When C-flute corrugated cardboard was selected, $t=4.5\text{mm}$, then substituting the formula, the size of all cardboard used was $1463 \times 280\text{mm}^2$.

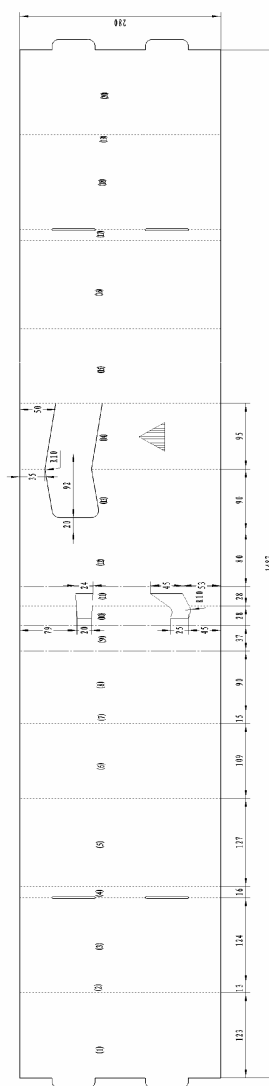


Figure 2. Cushion pad expansion plan of scheme 1

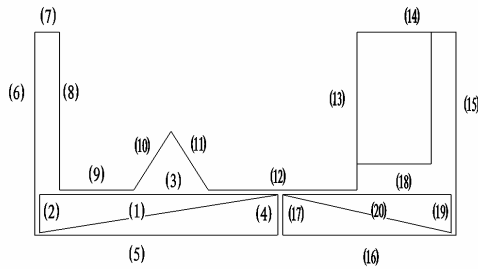


Figure 3. Three-dimensional structure side schematic view of scheme 1

3.4. Second Scheme

Based on the first scheme, the second scheme took into account the cost by reducing to two layers of the cushion. The horse's ears, mouth, tail and another two legs were designed to hang in the air too, but there were only two layer of corrugated cardboard between the horse's ears and outer packaging box, simultaneously the structure supporting the horse's legs was predigested. Reduced the height of the supporting sites, the two horse's legs were sunk deeper. (Fig.4 and Fig.5)

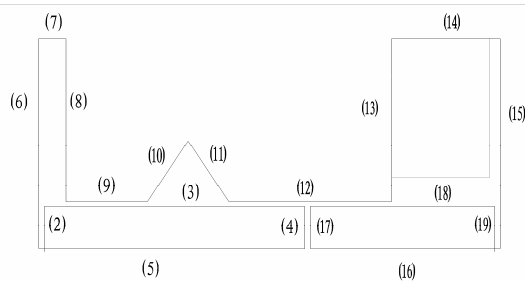


Figure 4. Three-dimensional structure side schematic view of scheme 2

Under the same conditions as first scheme, the size of the second cushion molded was $280 \times 260 \times 112 \text{ mm}^3$, (7) = 15mm, (8) = (13) = 90mm, (10) = (11) = 35mm, (12)=80mm, (14)=95mm. The size of all A-flute cardboard used was $1226.5 \times 280 \text{ mm}^2$, the size of all B-flute cardboard used was $1258 \times 280 \text{ mm}^2$ and the size of all C-flute cardboard used was $1236 \times 280 \text{ mm}^2$.

3.5. Design the Outer Packaging Box

In order to open and close with facility, selected packaging box # 0215. The outer packaging box was made of the F-flute corrugated cardboard, $t=2\text{cm}$, the manufacturing dimension of the outer box was $L = 285 + 2 + 2 = 289\text{mm}$, $B = 265 + 2 + 2 = 269\text{ mm}$, $H = 115 + 2 + 1 = 118\text{mm}$ (Fig.6).

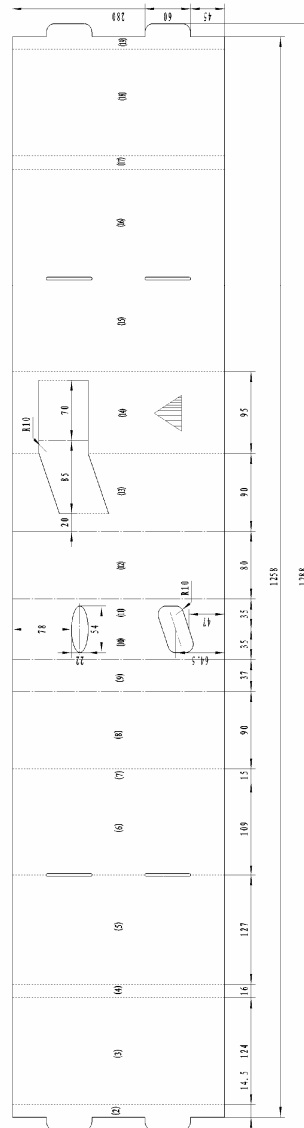


Figure 5. Cushion pad expansion plan of scheme 2

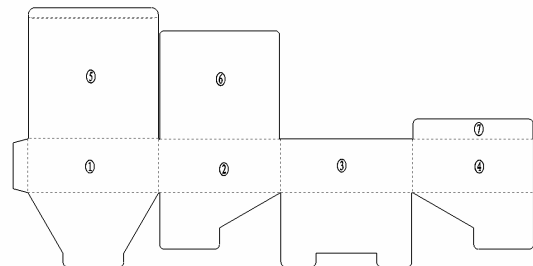


Figure 6. Outer pack box expansion plan

3.6. Calculate the Cost

According to GB/T4857.5-92, the formula for cost of cushioning package was $C_x = C_m V + C_p + C_{ic} + C_{ec} + C_1(P_m + P_p + P_i) + C_s$. The costs of all schemes were as

follows.

The original package's cost: the outer box was # 0211, if 2.1yuan/m², the area of the corrugated cardboard was 0.47 m², so the cost was 1.0yuan. If 120yuan/m³, the volume of the two EPS foam was 0.008855m³, the cost was 1.06yuan. Both of them were 2.06yuan.

First scheme: the outer box was # 0215, if 2.1yuan/m², the area of the corrugated cardboard was 0.66 m², so the cost was 1.4yuan. For the corrugated cardboard cushion, if A-flute used and 2.5 yuan/m², the area was 0.406 m², so the cost was 1.02yuan, and if B-flute used and 2.2 yuan/m², the area was 0.416 m², so the cost was 0.92yuan, and if C-flute used and 2.4 yuan/m², the area was 0.410 m², so the cost was 0.98yuan. Adding the cost of the outer box, both costs of A-flute, B-flute and C-flute were respectively 2.42yuan, 2.32yuan and 2.38yuan.

Second scheme: the outer box was # 0215, if 2.1yuan/m², the area of the corrugated cardboard was 0.66 m², so the cost was 1.4yuan. For the corrugated cardboard cushion, if A-flute used and 2.5 yuan/m², the area was 0.343 m², so the cost was 0.86yuan, and if B-flute used and 2.2 yuan/m², the area was 0.352 m², so the cost was 0.77yuan, and if C-flute used and 2.4 yuan/m², the area was 0.346 m², so the cost was 0.83yuan. Adding the cost of the outer box, both costs of A-flute, B-flute and C-flute were respectively 2.26yuan, 2.17yuan and 2.23yuan.

In addition, EPS cushion need the mould to make, and the apparatus was very costly, at the same time the foam cushion needed large space during transportation and storage. Otherwise the corrugated cardboard did not need expensive equipment and was convenient for transportation and storage by dead folding.

4. Have a Test

4.1. The Test Method

The test device was the drop test machine # PK-38 made in Dongguan Huasheng Instrument Co. Ltd., Guangdong province, China. Based on GB/T4857.5-92, there were three contrast experiments for two schemes. According to GB/T4857.18-92, the falling height was selected 60cm, 80cm, 90cm and one contrast experiment was composed of one set of face drop, four sets of edge drop and four sets of angle drop. From first face drop, second edge drop, to last angle drop, the whole test were performed in identifier sequence. After every experiment, outer box was opened to check in and write down the result.

4.2. The Result of Test

At falling height of 60cm and 80cm, the result of the experiment for first scheme was similar to that of second scheme. The horse's outside was no in disrepair with the cushion of all flute corrugated cardboard. The outer box

was sunken gently, the four corners at which the cushion touched the outer box were impressed slightly and the three connections supporting the horse's body had a spot of distortion.

At falling height of 90cm, in first scheme the horse's outside was no in disrepair, the outer box was sunken gently and the four corners at which the cushion touched the outer box were impressed slightly. The part of the cushion which supported the horse's body was deformed badly. The horse's ears punctured the cardboard. The inner cardboard was deformed badly. The horse's tail rubbed the cardboard.(Fig.7).



Figure 7. The breakage after the drop test at falling height of 90 cm in scheme 1

At falling height of 90cm, in second scheme for A-flute corrugated cardboard the horse's ears and the outer box were intact, but the cushion had been impacted by the horse while only one layer of the cushion had punctured. For B-flute corrugated cardboard the outer box were intact but one horse's ear was rubbed and only one layer of the cushion had punctured, the horse's tail was intact but paralleling to the horse's tail the cardboard had punctured.(Fig.8) For C-flute corrugated cardboard one horse's ear had ruptured, the cushion and the outer box both had punctured, and the horse's tail was intact but had punctured the outer box.(Fig.9)

4.3. Analyze the Result

According to the experiment the cushion in second scheme could protect the colored ceramic horse enough, i.e. the horse was intact and the cushion and the outer box had no disrepair. In second scheme there were added one layer of cardboard became two layers between the horse's ears and the outer box comparing to first scheme, but more material was not used. In second

scheme the depth of the cardboard clamping two horse's legs had increased while making the horse's legs fastness, foremost reducing the contact between the horse's tail and the outer box. The part of the cushion supporting the horse's legs had predigested to reduce the process cost.



Figure 8. The breakage of B-flute at falling height of 90cm in scheme 2



Figure 9. The breakage of C-flute at falling height of 90 cm

Both first scheme and second scheme, at the falling height from 60m to 90cm, the cushion of A-flute corrugated cardboard could protected the horse safety and the cushion and the outer box had not disrepair in evidence. Only at the falling height of 60m and 80cm, the cushion of B- and C-flute corrugated cardboard could protected the horse safety and the cushion and the outer box had not disrepair in evidence, but they had met the cushioning requirements. The cost of the cushion of A-flute corrugated cardboard was highest, then was C-flute corrugated cardboard, that of B-flute corrugated cardboard was lowest, but all had no marked difference.

Because the colored ceramic hors was light and had not large size, the cushion of B-flute corrugated cardboard were selected based on the cushioning performance, cost and attractive looks.

5. Conclusion

According to the material, structure and cost, the cushion for the colored ceramic horse was designed by second scheme with the cushion of B-flute corrugated cardboard and the outer box of E-flute corrugated cardboard, the cost of all packaging material was 2.17yuan.

Compared with the foaming plastic packaging, folding corrugated cardboard used to be the cushion was without remarkable advantage on costs and had added to some labor cost. But folding corrugated cardboard had the superiority of all cost of process, distribution and storage, also environment friendly. So folding corrugated cardboard used to be the cushion to protect ceramic artworks should been an important means to achieve packaging material simplification and offal reclaiming.

References

- [1] Zheng Xianjue and Sun Lan, "The Importance of Package in Ceramic Artworks", in Jingdezhen Ceramics, vol. 17, pp.41-42, January 2007.