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The Packaging Structure Design Computer-aided

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Abstract

Packaging technology has experienced the physical packaging, modern packaging and digital packaging three development stages ,with the computer technology's spurt advance and widely used ,it developed the scientific and efficiency of design. The paper mainly talked about the application of computer in packaging design from three aspects: product packaging materials performance test computer-aided, product packaging structure design computer-aided and product packaging test computer-aided.

Keywords**:** *Computer-aided, packaging design, packaging structure design*

1. Packaging Materials Performance Test Computer-aided

1.1 Cushioning Material Impact Testing Machine and Material Cushioning Performance Detection Software (as Figure 1 shows)

Equipment composition: Test machine, the control box, Multifunction data acquisition board, Piezoelectric accelerometer, The charge amplifier, Photoelectric speed sensor, Acquisition software seven pats.

Device parameters:

The maximum impact surface size of sample: 210mm×210mm

The maximum fall height: 1200mm

Figure 1. Cushioning Material Impact Testing Machine

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Cushion thickness and compression area design and calculation material's the minimum thickness and the minimum compression area are all connected with material's physical and mechanical properties, we used multigroup similar material test, got a lot test data, in order to ensure the reliability of the results, we analyzed data and calculated results by computer, and quickly obtain the ideal results. Take a random reading record and observe the experimental curve on the deflection and load, In order to reduce the error may appear of the experimental curve directly measured, when measuring the test number, adopt high density recording and measuring data to ensure the computer processing data and the ideal value with the smooth transition in the interpolation results, in addition, when measuring data, use the method of amplify experimental curve, increase the accuracy of data, finally draw a curve of variable-load by computer, Inspection records and measured data the fitting degree of the curves and experimental curves, so that can guarantee security of original data.

When the Cmin value is calculated by computer, the thickness of cushion can be calculated by the under formula.

$$t=C_{\min}\frac{H}{[G]} \quad (1)$$

In the formula:t represents cushioning material thickness(cm),

H represents fall height(cm), G represents product crisp value

Cushioning material's minimum buffer coefficient ,from formula(1),we can get that the t value has nothing to do with the product barycentric coordinates ,when designing, the four supporting points in a falling plane ,generally the same value which is the minimum thickness of ensuring the buffering effect.

The solution vector of formula (2).

$$[P]=\left[\frac{x'y'}{ab}W,\ \frac{xy'}{ab}W,\ \frac{xy}{ab}W,\ \frac{x'y}{ab}W\right] \quad (2)$$

Use vector [p] take the place of W in the formula (1), input original parameters W, product length, width and barycentric coordinates x,y can calculate the minimum buffer area of the fulcrum A1,A2,A3,A4.

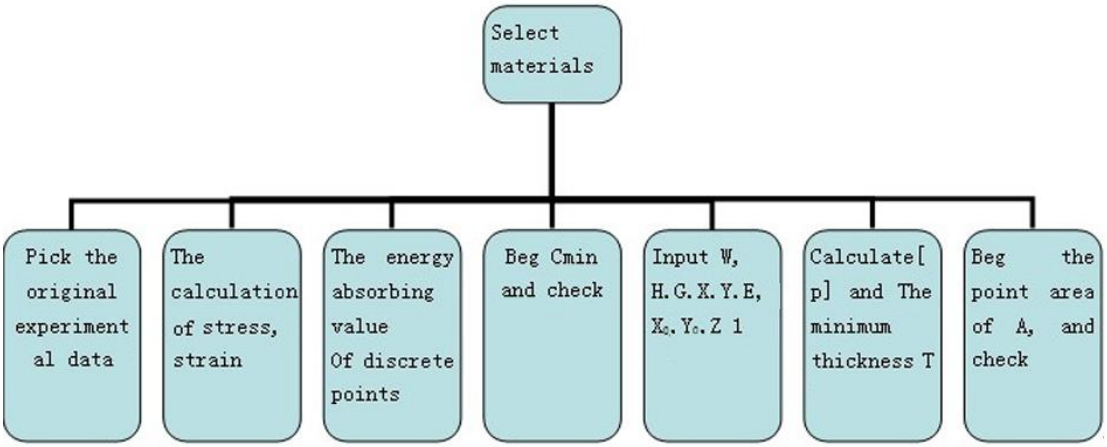
1.2 Universal Material Testing Machine and Supporting Software (as Figure 2 shows)

Equipment: testing machine, testing software system
Device parameters:
Stroke: 1000mm
Test speed: 10 - 100mm/min

Figure 2. Universal Material Testing Machine and Supporting Software

Cushioning material impact testing machine , Material buffer performance testing software and universal material testing machine and supporting software, which can check different packaging materials 'buffer performance, flexural, compressive properties. And provided scientific data supportance for packaging structure design ,So when we do the cushion packaging structure with more test data rather than personal experience of design .Buffer materials testing framework (as Table 1 shows)

Table 1. Testing Sequence



2. Product Structure Design Computer-aided

2.1 Product Packaging Two Dimensional Structure Design

With software technique's development, there is various software for two dimensional structure designs such as AutoCAD, Box Vellum, JWW.

Currently which is the most widely applied used in product packaging design of two-dimensional structure is AutoCAD.

AutoCAD is a design software computer-aided first introduced by Autodesk compare in America in1982, which used in two dimensional drawing, design file. After twenty years' continuous improvement and upgrading, now became aided design software combined two dimensional picture drawing, three dimensional modeling, database management, color rendering and international internet functions.

The reason for choice AutoCAD as a platform to study three dimensional modeling system:

Wide application range, high penetration rate, large coverage area .AutoCAD after growing and improvement has become the international popular drawing tools ,two dimensional drawing on the market share of more than 60%,are widely used in machinery, construction, electronics, metallurgy, geology, meteorology, geography, aviation, light industry *etc.*, dwg file format has become the de fact standard two-dimensional graphic format .AutoCAD has a good user interface, versatility and usability ,applicable to all types of users ,and running in the operating system supports a variety of microcomputer and workstation.

Strong openness .AutoCAD has opening system structure, and multi-language interface, allows users and developers who use AutoLISP, ADS, ObjectARX two development tools for the extension, to satisfy the special requirements of customers farthest. Users and developers

had successfully developed many application software based on AutoCAD in many practical applications such as Machinery, building, electron. Design case sketch up (as Figure 3 shows).

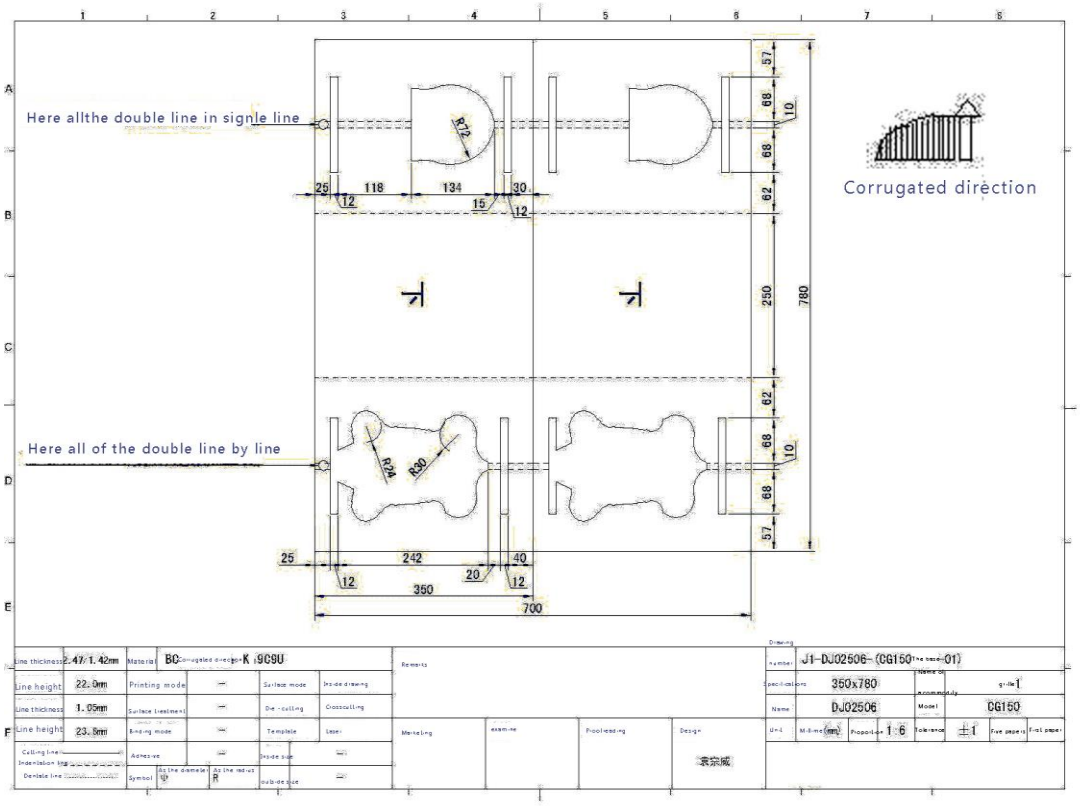


Figure 3. Design Case Sketch Up

Figure 4. Corrugated Cardboard Proofing Machine

When packaging structure design use CAD cooperate corrugated board for proofing, not only can output sample the same size as design picture, but also has an higher efficiency than manual sampling, complex product can achieve 100 times, so that can provide a better design platform for design and reduce design and develop cycle for consumers, to secure more orders for the company, achieve win-win effect.

2.2 The Product Three Dimensions Packaging Structure Design

Commonly used software in product three dimensions packaging structure design has two types UG and Pro/E.

2.3 Design Prepare Work

Fully work should be prepared before implementing three dimensions packaging computer -aided design, ① collect products' related information, to make clear product's packaging structure;②The performance of various packaging materials need scientific data support ,cushioning materials data ,As mentioned above, material flexural properties and compressive strength physical performance data and so on, that all need designer master ,only with these packaging materials' performance and related testing data ,can we do three dimensions structure design more scientific, more accurately.

Among them, what should collected of products' related information mainly include product's physical property, specific parameters and the characteristics of product structure and other product information to determine the basic of packaging method. In addition, the outer packing carton structure and the internal buffer structure's form, type and related calculation also need detailed product information as far as possible.

2.4 Establish Contents Three Dimensional Model

We deal abstractly about the products' related information collected ,then get the corresponding mathematical model ,based on that ,construct the model by three dimensions software .corresponding three dimensions model methods can be divided to direct modeling, sketch modeling and hybrid modeling (as Figure 5-7 shows) .

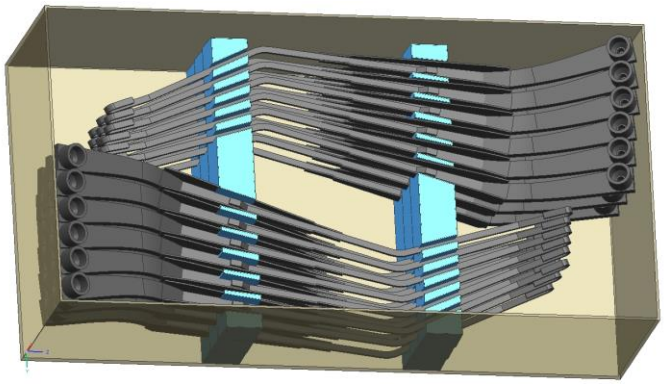


Figure 5. The Wiper Rod Packing

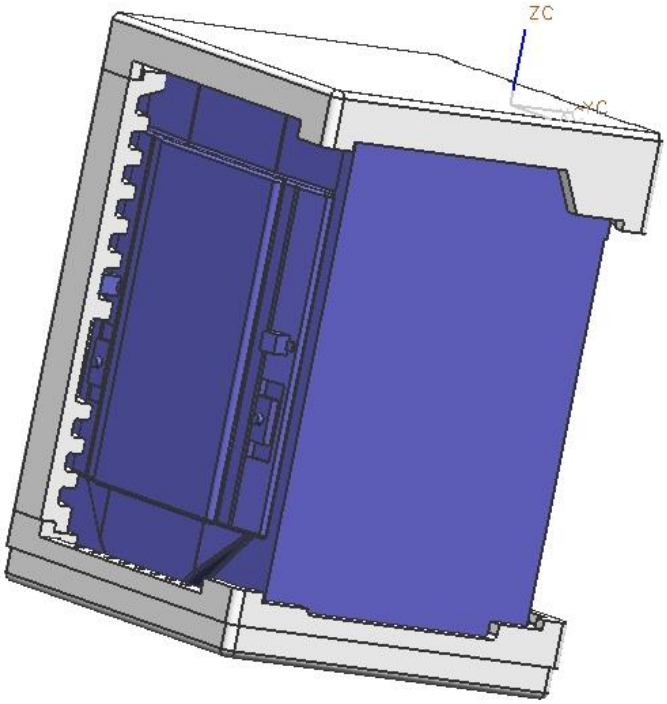


Figure 6. Refrigerator Packaging 1

The use of software in product packaging structure design can make design more intuitive, more specific, more scientific, the design efficiency can be greatly improved at the same time.

①Three dimensional design can be directly carried out one by one according to the product design, which can guarantee product and packaging's degree of adaptability, higher accuracy.

② Three dimensional structure design can conduct packaging design according to consumers' product three dimensional picture at the early stage of product development ,packaging can accomplish when customer product development end, that can reduce packaging's development time, to buy more time for the listing of new products.

③The using of three dimensional software can promote the application of packing parameter, which means the use of finite element in product packaging ,with the development of science and technology and computer's widely using ,in order to improve packaging design's efficiency and accuracy, reduce the packaging design's development funds, packaging design parametrization is an inevitable trend.

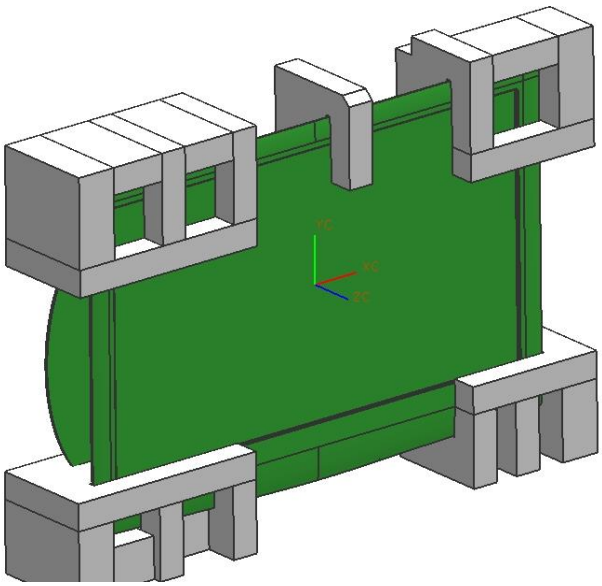


Figure 7. Refrigerator Packaging 2

3. Product Packaging Test Computer-aided

With the rapid development of computer science and technology, transport packaging play a decisive role in the field of packaging test, how to introduce the computer-aided testing in transport packaging test, in order to improve the test accuracy of the system, to reduce the test error, handling computer data at the same time, improve the analysis depth and work efficiency is a question deserved research.

Drop test machine and the fragility test system (as Figure 8 shows)

Drop test machine is an equipment that transport packaging adopted for drop test, used to simulate the impact that product packaging system experienced during the logistics process. The main machine is to let packaging set free from a certain height so that it can drop to the ground in a free fall way. The drop test can be divided into surface drop edge drop and corner drop, respectively investigated the effect that product packaging system produced in different dropping direction.

Drop test machine and the crisp value system

Drop test machine composition: control cabinet, drop table two parts.

Crisp system composition: high speed data acquisition card, IC piezoelectric accelerometer with three shaft built-in, three channel signal conditioner, acquisition software four parts

Device parameters:

The maximum test-piece weight: 300kg

Drop height: 0 — 1500mm

Test-piece maximum size: 1200mm×1200mm×1200mm

Plate size: 2300mm×2200mm

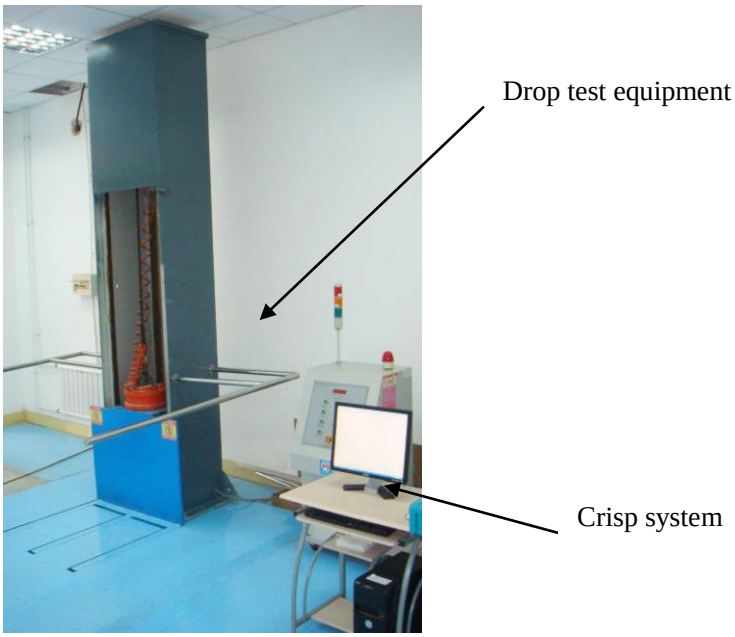
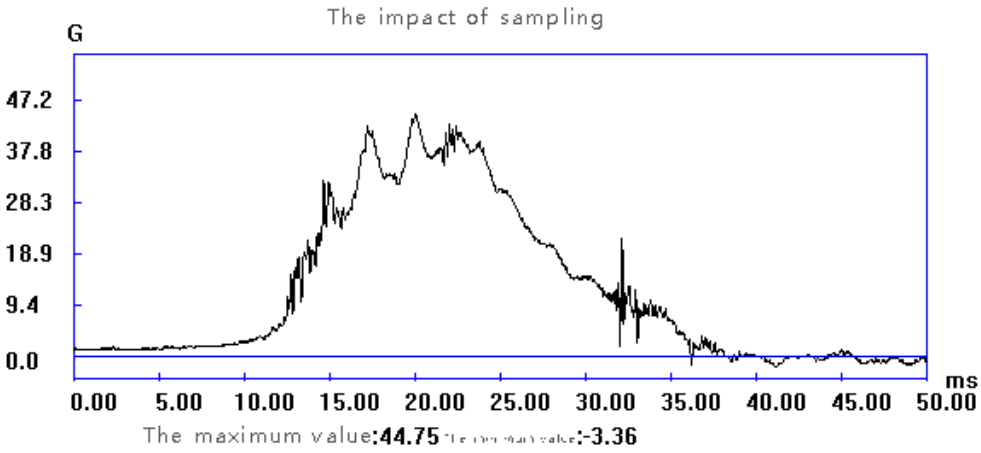


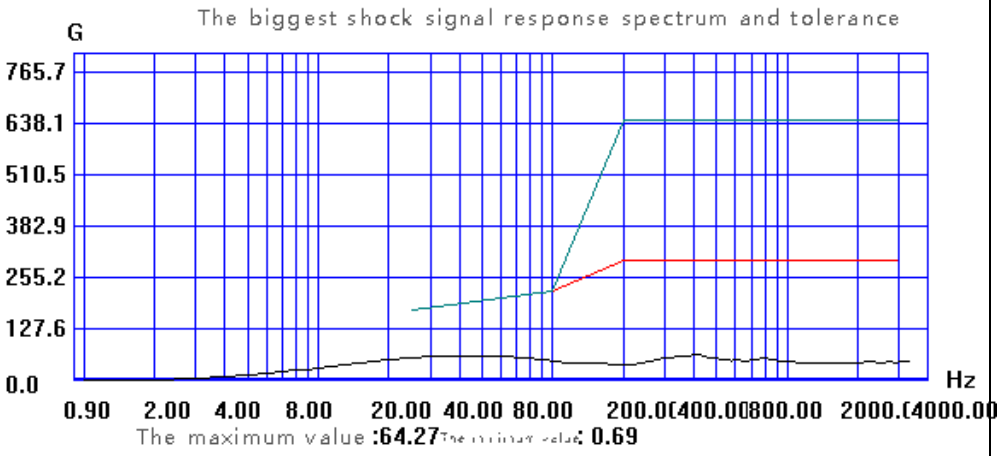
Figure 8. Drop Test Equipment and System

Table 2. Drop Impact Test Report

Customer name:***			Test sample name: Notebook computer		Product model: ***	
Standard:GB8171-87 ISO2248 ASTM D3332						
Test software:ITCZ-3.0						
Test device	name		The manufacturer		Model	Remarks
	Drop test machine		**		***	
	Accelerometer		***		***	
	Data acquisition card		***		***	
Sample	Weight (kg)	Size (mm^3)	Gasket materials	Density	Thickness	The crisp value
	4.6	449*414*219	EPE	0.019 g/cm^3	44.0 mm	
Test Parameters	Drop location	Drop height(㎜)	Pretreatment temperature(℃)	Pretreatment humidity(%)	Test temperature(℃)	Test humidity(%)
	Left side	76	30	70	30	70
Sampling parameters	Sampling frequency	Sampling points	Simulation low to frequency	Number low to frequency	The digital low pass to the transition bandwidth	
	40000Hz	2048	10000Hz	5000Hz	100Hz	
Test result	Test data	The maximum acceleration	Changing quantity of speed	Pulse width	Package state	

		44.75 G	3.87 m/s	20.5 ms	Normal





Note: sensor installation location: The reference point for the front left corner x:155mm,y:45mm the calculation of SRS damping ratio is 0.05

Test :	Proofreading:	Examine:
Date of test:		

4. Inclined Impact Test Machine and Impact System

Impact system used to measure and confirm product's crisp and evaluate the packing protection, data got from data used to reduce product damage in transport link in great extent. Vertical impact test machine made of guide rail, shock machine, generator, and impact mass. When testing, transport packaging should connect to shock platform, it impact to the mass with shock platform and impact wave predetermined by program generator.

Inclined impact test machine

Equipment composition: baffle, trolley, slide, hydraulic cylinder, the control box five parts

Device parameters:

The maximum load: 1000kg

The maximum collision speed: 0.5 - 2.8m/s
Trolley table size: 1520mm x 1520mm
The collision area: 1800mm * 1800mm
The maximum glide distance: 2900mm

Figure 9. Vibration Test Bench and Test System

Vibration test bench is the device that transport packaging adopted for vibration test, and simulation vehicles or ships and aircraft vibration during transport process. The main method is let fixed package and the vibration test bench, performed the test according to different vibration frequencies, to study the impact of product packaging system for packaging different in vibration frequencies(as Figure 9 shows).

Vibration test stand
Device composition: control cabinet, the shaker, oil source, cooling water tank four parts
Device parameters: The table maximum load: 1000kg
The maximum thrust: 25000N
Work frequency: 1 - 200Hz
The maximum displacement of P - P: 100mm
Table size: 1200×1200mm
The vibration direction: vertical vibration

Figure 10. FCL Compression Testing Machine and Testing System

FCL compression testing machine and testing system is the device that transport packaging used for empty antibody, stacking compression test, simulate the products in storage and

stacking in transportation process .The main way is let outside box or other products fixed on working table, then applied equalization pressure on product, until the deformation damage, mainly study the effect that packaging produced on product packaging system in different pressures (as Figure 10, 11 shows).

FCL compression testing machine

Device composition: FCL compression table, test software system two parts

Device parameters: measuring range: 0 - 50kN

Plate area: 1500mm * 2000mm

Working stroke: 1500mm

Figure 11. Testing System

Packaging materials detection performance computer-aided, product packaging design computer-aided, product packaging test computer-aided fully embodies the role of computer in packaging design, with the development of science and technology and the application of computer ,in order to improve the efficiency and accuracy of packaging design and reduce the expenditures of product packaging design ,computer-aided design in packaging structure is an inevitable trend.

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