

# Expiry detection of honeycomb structured green pallets: A case study

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## Abstract:

Due to the recent global push for adapting green technologies in logistics industry, environment friendly corrugated or honeycomb structured green pallets will be used extensively in future transportation systems. Also, there is no need of International Standards for Phytosanitary Measures (ISMP) 15 for export of green pallet. Many other advantages are observed during the use of these types of pallets in logistics operations. The main drawback of the green pallets is their durability which is lesser than other types of pallets. This drawback became the reason of accidents and increase in cost of the production in industries. In this paper, a case study is presented which has been performed in a green pallet industry (XYZ Pvt. Ltd.) based in Delhi-NCR state of India. This company makes the honeycomb structure based green pallet. An idea is proposed by which the expiry of such pallets will be determined and labeled using regression models and RFID based tags so that the accidents in industries can be minimized. Strength test for the calculation of time to sustain the particular load is an important test to consider for the estimation of the expiry date of honeycomb structure based green pallets. These tests have been performed on an in-house Universal Testing Machine (UTM). Regression analysis has been done for the expiry generation by using Microsoft Office Excel 2007 software. A Radio Frequency Identification (RFID) based approach has also been discussed briefly for the detection of expiry prior to the usage of green pallets.

## Keywords

Green Pallet, Expiry Detection, Regression Analysis, RFID Technology, Honeycomb Structure Pallets

## 1. Introduction

Industrial pallet is a component of material handling equipment which is a small unit but can become a safety hazard if not used properly. Industrial pallets can be classified on different basis like design based Pallet, material based pallet, load capacity based pallet etc. The material based pallets are five types such as wooden pallet, metal pallet, composite pallet, corrugated pallet and composite pallet. In this paper the main consideration is on corrugated pallet which is also popularly known as green pallet because they can be recycled many times

with lesser environmental impact than other material pallets. Green pallets are very light in weight and possessing characteristics such as very easy and safehandling, lessercost, easysshipment, less transportation cost, great folding capability, no need of ISMP-15 regulation etc. A latest survey shows that in developed countries, cost of logistics is 9-11% of the GDP [1]. Therefore, it is essential to minimize the overall cost of logistic operation by reducing the cost of pallets.

The problem with green pallets is the durability which is lesser than other types of pallets. Also, there is no way to detect the expiry of pallets which could be the reason of accidents in industries. These drawbacks can increase the overall cost of production, increase the time of production, increase laborhazards etc. The solution for the expired green pallet is to generate the expiry date and the detection of that date with the help of radio frequency identification (RFID) tags. The expiry date generation can be done by testing the strength of green pallets, creating some statistical models and putting RFID tags on pallets. Attached RFID reader and LCD (Liquid Crystal Display) will show the total number of shifts taken by a particular pallet. This will give an idea to the worker about the shifts of a pallet and if the number of shifts exceeds the permissible limit then the entry gate will not open and will not allow the loading. In that case, it will be essential to check the pallet, and if require,repairing and reuse will be done. If the pallet is in a much damaged condition then the recycling will be done and the ID of that particular pallet will be allocatedto another pallet.

This paper presents a case study of a green pallet manufacturing company (XYZ Pvt. Ltd.) based in Delhi-NCR state of India. An idea is proposed by which the expiry of such pallets will be determined and labeled using regression models and RFID based tags. This paper is organized as follows. In section 2, a review of previous work and literature is presented. Section 3 describes the methodology, drawbacks of green pallets and alsodescribes the case company. Section 4 focuses on regression analysis and RFID implementation approaches. Section 5 discusses the results and conclusions along with the future directions.

## 2. Literature Review

Pallet is basically used for the material handling with Automated Guided Vehicle (AGV)in industry.They can also be divided on the basis of configuration and sizes in which two broad categories are 1) Stringer Pallet2) Block

Pallet and the standard sizes are 1000mm×1000mm, 12000mm×1000mm [2]. Another way of classification is two way pallet and four way pallet. This paper main concern is the classification of pallet on the basis of material. The comparison of the entire pallets is shown in table no 1.

**Table 1. Comparison of different types of pallet**

Factors	Corrugate d pallet	Wooden pallet	Metal pallet	Composite pallet	Plastic pallet
Safety of worker	High	Lower	lower	Lower	high
Recycle	Yes	no	yes	Yes	yes
weight	Light	heavy	heavy	Heavy	light
durability	Less	high	Very high	Very high	high
Cost	Lower	higher	higher	Higher	higher

Now the word is moving towards the “Green World”. Green is directly related to environment friendly world and because of this the contribution in pollution by the pallets manufacturing and disposal cannot be neglected. Green pallets are the pallets which gives the recyclability facility many times with the lesser pollution. The advantages of corrugated pallets are the following.

**2.1 Lesser weight-** Green pallet’s weight is very less because of the using paper in manufacturing. The weight of green pallet is 4 to 6 Kg whereas the wooden pallet has the weight 10-14 kg.

**2.2 Easy Handling-** Light weight of green pallet gives the facility to worker for movement of many green pallets at a time.

**2.3 Lower cost-** The cost of the Green Pallet is much lesser than the other material pallets which also reduce the total cost of the production.

**2.4 Recyclable-** The same material of the corrugated pallet can be recycles many times and can use with the same efficiency and that is why known as “Green Pallet”.

**2.5 Lower transportation cost-** Green pallets allows the folding facility and because of that they can be transfer from one place to another place 4 time lesser cost then to wooden pallet.

**2.6 Safety-** Corrugated pallet not used the sharp things like nails which may cause the problem for the worker and injured them.

**2.7 Time saving-** Due to light weight, and easy use the green pallet can easily be managed and which reduced the accidents in the industry which save time because no need to recover from the accidents.

**2.8 No need ISMP 15 Regulation-** ISMP15 is a standard in which the heat treatment is given to the wooden equipment for the export to another place. But Green pallet needs not to regulate under ISMP 15 which reduced cost and also save the time.

### 3. Methodology

Corrugated pallet has many advantages as described above but also has some disadvantages in which the less durability is the main issue. The less durability makes green pallet expired and they become the reason of accidents in the industries. The losses occurred due to expired green pallets are as follows.

*Cause of accidents:* Expired green pallet can be the reason of accidents because of inbetween broken of the pallet at the time of carrying load.

*Increase the cost of the Production:* Due to accidents the load which is carrying on the expired green pallet can be damaged and will become the reason of increase of overall cost of production.

*Security and safety factors of Worker:* In an industry all the units do work simultaneously and synchronizes with each other. At the time when the expired green pallet is moving with load in industry and worker also doing their job then the security and safety factor of worker decreases.

*Increase the time of production:* Time will be required for the cleaning of space nearby accidents area which had caused by the expired green pallet and make other units blocked. Indirectly the production rate will decrease or time of production will increase.

*Late delivery of the product:* The increase in time of production will also increase the time of delivery which affects the customer satisfaction.

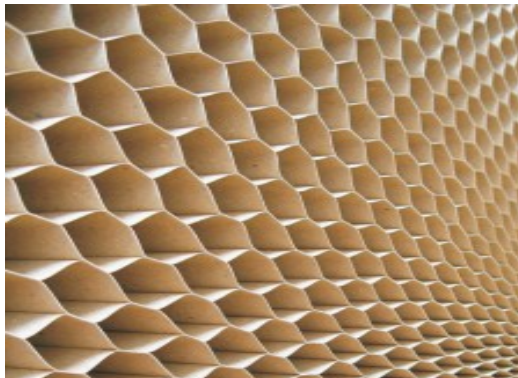


**Figure 1. Honeycomb Structure Based Green Pallet [8]**

The Green Pallet has very lesser durability and the handling by worker also make them more unreliable. To generate the expiry of green pallet firstly the testing is required and then after testing automatic detection of the expired green pallet is required which will detect automatically the expired pallet and prevent the accidents.

#### 3.1 The case of XYZ Pvt. Ltd.

XYZ Pvt. Ltd. a green pallet industry study shows the following specification of their Honeycomb structure based Green Pallet. Honeycomb Green Pallet is recyclable, very smooth without any nails and totally biodegradable material. For attachment of the legs to the honeycomb board adhesives are being used. Green pallets of XYZ Pvt. Ltd. are available in four ways, two ways and emergent two ways types [8].



**Figure 2. XYZ Pvt. Ltd. Honeycomb Core [7]**

The paper used in construction of honeycomb core is 140-180 GSM recycled paper and can be replace thermocol which is not recyclable. Machine used by the industry for expanding of core is *Packraft 1200/4B* model [10]. To generate the expiry of green pallet the most important factor is compressive strength. The testing of the sheet of the pallet will shows the time to bear the maximum load. Another factor is handling of the green pallets by the workers. The handling factor also decreases the reliability of the green pallets and can be overcome by the using of robot with AGVs.

### 3.2 Testing the load sustainability of green pallets

The data which is provided by the XYZ Pvt. Ltd. is mentioning the compressive strength of green pallets but the load bearing capacity is not available. The test for load bearing has been done on the Universal Testing machine (UTM) which gives the maximum time limit for bearing the unit load on to the Pallet.

## 4. Regression analysis and expiry detection

Regression model is aimed to define the relationship between the independent variable X and dependent variable Y [5]. In this study, independent variable is load and dependent variable is time. The data provided from the testing of sustainable time has used for generation of the expiry of green pallet.

**Table 2. Specification of Studied Green Pallet**

Product Name	Honey Comb Cladded pallet
Height	130mm, Fork Height- 90 mm
Weight of the	6.5 to 7 Kg

Pallet	
Top sheet	30 mm thickness, 8 mm Cell Size, 180/350
Bottom Sheet	10 mm Polycoated. Complete blocks are cladded with three ply corrugation micro flute polycoated paper.(to bear the moisture effect)
Dynamic load	700-800 Kg, Distributed not Pin Point
Paper Specification	Total Recyclable paper. Core – 180 GSM Waste Board Lamination – top Paper – 350/400 GSM Bottom- Poly Coated Virgin Craft Paper 350 GSM Paper
Adhesive	PVA, Good in Sea Environment Water Repellent, Save from indirect contact of water

Multiple R is the correlation coefficient which is showing the 89.44% strong linear relationship between load and time. R square is co efficient of determination which shows 79.9% of the values had fit in the linear model. Standard error is basically the definition of residuals and not showing any experimental error. Confidence level in regression analysis has set 95%. The observation is showing the no of time experiment has performed.

**Table 3. Testing results on different load**

Load (Kg)	Sustainable Time (Minutes)
100	1800
300	900
500	700
700	600
900	450
1000	376

ANOVA analysis regression  $df$  is denoting the number of independent variable in the experiment and for this paper regression  $df$  is 1[6].

**Table 4. Regression Analysis**

Regression Statistics	
Multiple R	0.894392024
R Square	0.799937093
Adjusted R Square	0.749921366
Standard Error	261.0164536
Observations	6

Sum of square (SS) of Regression shows the variation of the group means around the overall mean. Mean square (MS) of Regression shows the standard deviation and calculated from SS of regression and *df*. Regression of F is calculated from SS and MS of regression. If the significance of F is not less than 0.1 or 10% that shows the correlation is not meaningful.

Table 5. ANOVA Table

ANOVA	df	SS	MS	F	Significance F
Regression	1	1089644.977	1089645	15.9937	0.016140642
Residual	4	272518.3562	68129.5		
Total	5	1362163.333			

In this paper analysis for the experiment shows significance of F is 0.016 or 1.6% which is good. Residuals *df* shows the degree of freedom and sum of square of residual shows the difference between the predicted values of Y and actual value of Y.

	Coeff	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1585.041096	222.4049195	7.126826	0.002049	967.5460459	2202.536146
Load (Kg)	-1.338356164	0.334654815	-3.99921	0.016141	-2.267506887	0.409205442

Mean square error of residuals is calculated from residuals *df* and SS. Total *df* shows the total degree of freedom of equation and sum of square shows the difference between the Y values from equation and average value of Y. Intercept 1585.04 shows the time value when the load is assumed zero. Load is -1.338 which is basically showing the slope of the linear equation. P value shows the probability that how much the null hypothesis is true. It must be less than 0.05 and the regression analysis are showing the 0.0020. So we can reject the null hypothesis and accept the significantly different conditions. Lower 95% and Upper 95% is showing the limit of the intercept and the slope which is load.

#### 4.1 RFID based expiry detection

Radio frequency identification (RFID) technology works on radio frequencies for the completion of the different desired purposes and it contains a reader, tag and a network [4]. After the generation of expiry of green pallet through the regression analysis method the automation can be provided by the Radio Frequency Identification Technology. RFID Tag has a unique

Identification number or the identification number can be generated by the user also. The success of tag detection is based on the received signal strength by the RFID reader [3]. A database for the particular green pallet can be generated and the unique RFID tag is attached with the green pallet. These tags can be attached at any side of the green pallet upper board of green pallet because RFID is not bound to line of sight of communication.

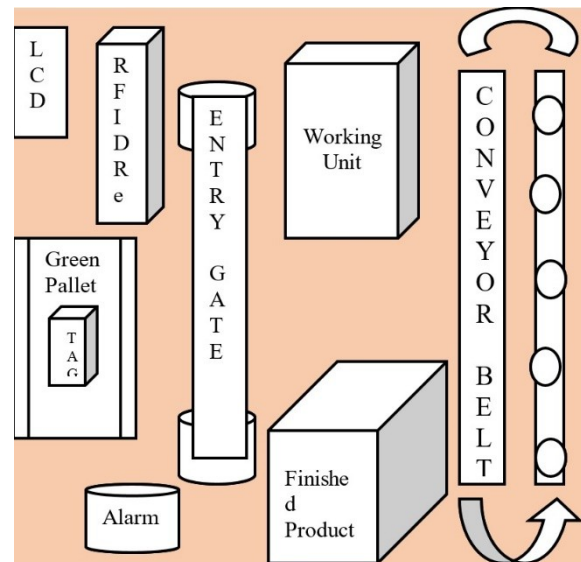


Figure 3. Layout for expiry detection

RFID reader would present at the entry gate of the industry from where the loading and unloading is started on to the green pallet. The reader will detect the ID of the particular pallet when the pallet will be in the range of the RFID reader. The database for the particular pallet will be created and stored in the host computer. The database for the pallet which will be in the range of the reader will be open on detection of the tag. LCD display will show the number of shifts remain to expire the green pallets. Alarm will start when the shift count will become 1. It will make aware to the workers that the currently working green pallet has expired.

The RFID Tag will be attached with the green pallet and a particular ID will be provided to each of the green pallet. When the pallet with load is come across the RFID reader the tag will be detected and the database for that particular pallet will be open. At the time when shift will become zero then alarm will make aware about the expiry of the green pallet currently using. At that time, particular green pallet required to be repaired or if need then recycling and change the database by the administrator is required.

#### 5. Result and Conclusion

Regression analysis of the tested data gives an equation,  $Y = 1585 - 1.338X$ . The parameter Y shows the time in minute and X shows the load in Kg.

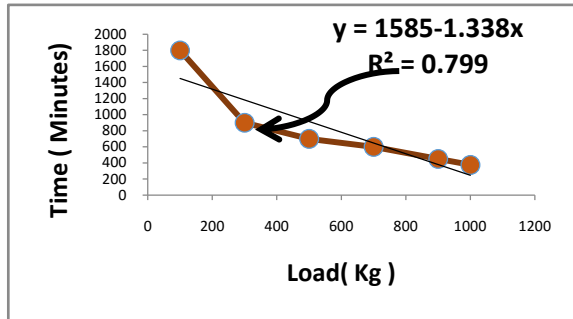


Figure 3. Graph from the Regression Analysis

The generation of the expiry with the help of regression analysis for XYZ Pvt. Ltd. has been done in previous section. RFID based detection of expiry of green pallets has also been explained. The expiry detection of green pallets will increase the reliability of the green pallet in the industry and its ecofriendly nature will make it usable many times and helps to save the tree and our Earth. To take more accurate data, other factors such as the material of the pallet, design of the pallet, different structure between two sheets, the handling etc. can also be considered in future studies. Handling is basically depending on how to use the green pallet by the worker. Also, the use of the robot to handle green pallets will also increase the reliability in the industry.

## 6. References

- [1] Zhang Qinghua, Wei Jun, Cheng Guoquan, Wang Zhuan, Yan Dawei and Zhao Shanshan, "Pallet rental information system based on RFID," 2009 4th IEEE Conference on Industrial Electronics and Applications, Xi'an, 2009, pp. 886-891, doi: 10.1109/ICIEA.2009.5138279
- [2] M. Jo, S. H. Cha, H. Choo and H. H. Chen, "Prediction of RFID tag detection for a stationary carton box," 2008 3rd International Conference on Sensing Technology, Tainan, 2008, pp. 248-253, doi: 10.1109/ICSENST.2008.4757107
- [3] S. Lu, Y. Wu and Y. Fu, "Research and design on pallet-throughout system based on RFID," 2007 IEEE International Conference on Automation and Logistics, Jinan, 2007, pp. 2592-2595, doi: 10.1109/ICAL.2007.4339017
- [4] J. O. Rawlings, S. G. Pantula, D. A. Dickey, "Applied Regression Analysis: A Research Tool, Second Edition", ISBN 0-387-98454-2 Springer-Verlag New York Berlin Heidelberg SPIN 10660129.

- [5] [https://en.wikipedia.org/wiki/Degrees\\_of\\_freedom\\_%28statistics%29](https://en.wikipedia.org/wiki/Degrees_of_freedom_%28statistics%29)
- [6] <http://www.packraftindia.com/docs/Safecore%202012.pdf>
- [7] <http://packraftindia.com/packraft-paper-made-pallets-honeycomb-pallets-angleboard-pallets-plastic-legged-pallets-2-way-4-way-cladded/>
- [8] <http://www.packraftindia.com/http://packraftindia.com/safecore/undertanding-honeycomb/>