Design and Analysis of Stacking Industrial Pallets for Handling Engine Blocks

Syed Sajid Ahmad Syed Nisar[1] Prof. K.I. Ahmad[2] Prof. M. Shakebuddin[3]
[1]Student [2]Associate Professor [3]Assistant Professor
[1,2,3]Department of Mechanical Engineering
[1,2,3]A.C.E.T Nagpur, Maharashtra, India

Abstract— Now a day in the fast growing industrial life every industry wants speed in manufacturing to cope up with the requirement of customer's. The basic aim of this project is to develop a minimum weight or low cost industrial pallets for handling engine blocks with safe working conditions. Generally standard pallets are used in all the industries, because they are easily available in the market. But when we say about handling of the engine blocks from one place to another place by using pallets it is necessary to check all the conditions related to failures occurred. The pallet design must be optimized and simulated for the critical behaviour of pallet. The design of pallet is simulated for the transportation and stationary (stacking condition) with the use of FEA analysis by using standard analysis software hyper mesh and design is also done by using standard CAD software. Handling of material is a very broad topic of science discussion in industrial transportation. From this we have to achieve faster transportation. To achieve the faster transportation new approaches and ideas are required, therefore the main idea developing behind such a design is to demonstrate the situation of pallets utilization in industries and related affecting factors. The final model is a combination of standardize processes and the simplicity ideas.

Key words: 3D CAD Modal, FEA, Material of Pallet

I. INTRODUCTION

A pallet is a flat structure used as a base for movement of automated or manual handling of goods in the supply chain. It is used to protect, store, and transport goods in the supply chain, while being handled by material handling equipments such as forklifts, pallet jacks or conveyors, stored in racking or bulk storage, or transported in transport vehicles. The pallet is the most common base for the single or unit load. Pallets are manufactured from the variety of materials. The wood pallet dominates the marketplace but plastic pallet, paper pallets, composite pallets and metal pallets also have a presence. This research deals with handling number of engine blocks from one place to another place from single pallet. And put those pallets in the stacking form.

When it comes to long time storage or longer duration the metal pallets are the best to be employed. Priced costlier than the wooden ones but compared to long term usage these are cheaper. Metal pallets are mainly used for heavy loads, high stackable loads, and long term storage. Metal pallets are made up of different materials like carbon steel, stainless steel and aluminium. Compared to all these pallets the carbon steel pallets are more durable and lighter in weight. Stainless steel pallets do not require any coating paint against corrosion and preferred for clean environment usage.

II. LITERATURE SURVEY

Manoj P. Talele, Ashok J.Keche – This research paper conclude that on the analysis result and the practical work it seen that the welded design is safer in the small capacity engine at large quantity transportation because of strength, reused and recycled are the benefits of this type of pallets. [1]

Abdullah Waseem, Ahmad Nawaz, Nauman Munir, Bilal Islam, Sahar Noor- In this research a pallet is designed and analyzed by comparing various materials on Pro-E and Ansys respectively. Analysis is done by considering uniformly distributed static force on pallet. [2]

Sourabh R. Dinde and Rajashekhar S.Talikoti- According to the structural point of view industrial packet rack structure can be considered typical steel framed structure. This work presents a general analysis of an industrial pallet rack structure, evaluating the influence of each of the components on the global stability. The aim is to braced/unbraced frames were design and their analytical models are to be built in software. [3]

Benoit P Gilbert, Lip H. Teh, Romain X. Badet and Kim J.R.Rasmussen- This paper analyses the influence of horizontal bracing restraints provided by the pallets on the behavior and design of steel drive-in racks. The pallets are shown to significantly influence the bending moment distribution in the uprights. The single upright model presented by Godley was improved by including the restraints provided by the rail beam and the pallet. Comparison with advance 3D finite element analyses showed that the improved single upright model was able to accurately reproduce the bending moment distribution in the upright in the down-aisle direction under gravity and out-of plumb loads. [4]

M.H.R. Godley, R.G. Beale and X. Feng- This paper present an efficient approach to the analysis and design of unbraced pallet rack structure subjected to horizontal and vertical loads. The structures are analyzed by considering an equivalent free-sway column and solving the differential equation of flexure. Results of the analysis are compared with a traditional non-linear finite element solution of the same problem. [5]

E. Soury, A.H. Behravesh *, E. Rouhani Esfahani, A. Zolfaghari (Design, Optimization and Manufacturing of Wood – Plastic Composite Pallet): This paper presents the application of an innovative method of optimization to the design of an I-shape profile used in a wood–plastic composite (WPC) pallet. The pallet was made via assembling three WPC extruded profiles manufactured in the extrusion process. The middle profile was considered to be I-shaped, a design which known to have a high load bearing capability. However, due to the characteristics of WPC products, a delicate design and thus optimization is

highly required. A multi-objective-optimization program of micro-genetic algorithm was developed in Visual Basic environment to accomplish the optimization task. By specifying the dimensional variables of the profile section and applying finite elements analysis on the profile and then using the optimization program, an optimal profile section was obtained. The objective was to withstand the maximum load while yielding the minimum deflection and mass. The optimized design was used to manufacture a die and then the product was produced to validate the design. The comparison of simulations and experimental results indicated that the given design method is reasonably reliable. The final mass of the produced pallet was less than 20 kg whereas it's strength against bending and distributed smooth restraint loading were greater than 500 kg and 2000 kg, respectively.A micro-genetic algorithm was applied for design optimization of an I-shaped profile of a wood–plastic composite used in structural applications such as pallets. The principle purpose was to reduce the total weight of the final product while maintaining the sufficient load capacity. The procedure led to an optimum design specifications which were also analytically verified. The selected design was used in manufacture of the die and experiment was carried out to produce corresponding WPC profile which then was mechanically tested. The results can conclude the followings:

- Multi objective micro-genetic algorithm is a suitable tool for optimizing the multi objective problem; here mass and deflection.
- The final selected optimum point was selected as the slope is sharply changed in the diagram of Mass–deflection obtained from the algorithm analysis.
- The mechanical tests showed a fair agreement between the empirical and finite element analysis results.
- The produced pallet was found to reasonably exhibit the targeted characteristics: mass and strength. [6]

Hande Yaman and Alper Sen (Manufacturer's Mixed Pallet Design Problem): We study a problem faced by a major beverage producer. The company produces and distributes several brands to various customers from its regional distributors. For some of these brands, most customers do not have enough demand to justify full pallet shipments. Therefore, the company decided to design a number of mixed or ''rainbow pallets so that its customers can order these unpopular brands without deviating too much from what they initially need. We formally state the company's problem as determining the contents of a pre-determined number of mixed pallets so as to minimize the total inventory holding and backlogging costs of its customers over a finite horizon. We first show that the problem is NP-hard. We then formulate the problem as a mixed integer linear program, and incorporate valid inequalities to strengthen the formulation. Finally, we use company data to conduct a computational study to investigate the efficiency of the formulation and the impact of mixed pallets on customer's total costs.

In this paper, we study a manufacturer that is designing standard mixed pallets for its various customers (that are differentiated by their demand mix) that cannot justify full pallet shipments for every product that they demand. We state the problem of the manufacturer as determining the designs of a given number of mixed pallets so as to minimize the total inventory holding and backlogging costs of its customers. First we show that the problem is NP-hard. We develop a mixed integer linear programming formulation and valid inequalities to strengthen the formulation. Our numerical study shows that the incorporation of mixed pallets improves the performance of customers considerably, even with restrictions and a limited number of mixed pallets. Our numerical investigation also shows that the valid inequalities help significantly in reducing the solution times, but the problem remains to be difficult for instances with higher dimensions. Therefore, one straightforward extension of our study would be the development and testing of heuristics. One may also consider the incorporation of manufacturer's own costs (such as inventory holding cost of pallets) to the model. Although the specific company that motivated this research works with customers with deterministic product demands, another logical extension is the introduction of probabilistic demands to the problem. [7]

Abdullah Waseem, Ahmad Nawaz, Nauman Munir, Bilal Islam and Sahar Noor (Comparative Analysis of different Materials for Pallet Design using ANSYS): Pallets are used mostly in storing heavy and large items in different industries across the globe. Reason for using pallet is to ensure safe material handling and storage of the material. Wooden pallets are usually used in industry. But wood is unfortunately not suited by environmental conditions in Pakistan. Hi Tech Plastic Industry, WahCantt is an industry that manufactures pallets for different defense related organizations in Pakistan. In this research a pallet is designed and analyzed by comparing various materials on Pro-E and ANSYS respectively. Analysis is done by considering uniformly distributed static force on pallet. From the results obtained from analysis done on pallet using ANSYS suggests that PVC made pallets are excellent in comparison to other pallets because of less deformation in shape as compared to other material pallets used in this analysis.

With the help of this research it will be helpful in selecting the materials for a specific application. So without losing so much energy and money one can decide whether to select a certain material or not. This research will help in establishing a method of selecting materials on the basis of their behavior shown by different materials when subjected to different inputs.

Software analysis needs maximum parameters or inputs to be interpreted very concisely. Sometimes the software results can differ from the practical results.

In future further work can be conducted by manufacturing extrusion die and pallet. The tests should be conducted in real and those results should be analyzed with these simulated results.

Secondly, all standard tests i.e. bending, full deck, rigid drop, impact test of stringer can be conducted by simulation software's and practically by conducting different standard tests and experiments.

Thirdly, these pallets can be tested in storage systems and comparative results like Ahmad can be obtained using statistical tools. [8]

Rahul. V. Mahajan and S. T. Bagde (Development of Low Cost Palletizing Cell for Handling Different Carton Sizes): Modern palletizing systems are designed mainly for

performance and flexibility. In today's competitive scenario, the cost of palletizing system, its installation lead time and its proper integration with material transport system present inside the plant are the factors of major concern for any industrial engineer. At the same time the system he designs, should be flexible enough to accommodate some basic anticipated changes with minimum setup time. Industrial Robots and Automated Inline Palletizers are widely used in industries for the palletizing operation. But neither of these provides a complete solution. E.g. Automated Inline Palletizers are fast enough but cannot handle situations involving 1. Drastic changes in carton sizes and 2. Different pallet layer configurations. It is because of lack of programmability. On the contrary, robots are programmable but consume programming downtime. The present paper proposes a model of an entire palletizing cell which is not only cost effective, but also flexible enough to accommodate frequent changes in sizes of cartons with almost negligible setup time and therefore negligible downtime. The paper describes the schematic configuration of proposed model as well as it explains how this model conquers the limitations of present available palletizing facilities mentioned above. [9]

Pradip Vasantrao Kadam and N.V.Hargude (A Review on Optimization of Rotary Table Pallets): An Optimization of pallet weight is a key point to be considered for lean manufacturing, cost reduction & effective operations. An effort for optimization of pallets has been carried out by many researchers using various methods considering static & dynamic loading conditions. The maximum deflection & stress developed within the permissible limits. This paper is an attempt to focus on efforts for review of optimization of weight of pallet & strain in pallet arm. This shows that many authors have reported the pallet design for rotary table and automatic pallet changer and also analyzed the pallet for different loading and working conditions. But still there doesn't exist any focus on designing the pallet which can suit both rotary table and pallet changer. [10]

III. ANALYSIS

A. FEA of Staking Pallets And Linear Static Analysis

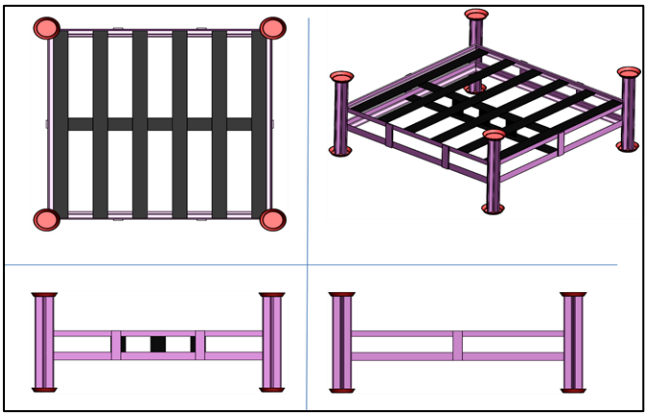

Fig. 1: Stacking pallets

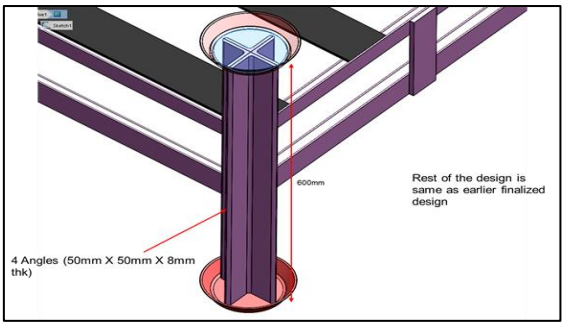

Fig. 2: 10.59KN Load for 3Pallets stacked above

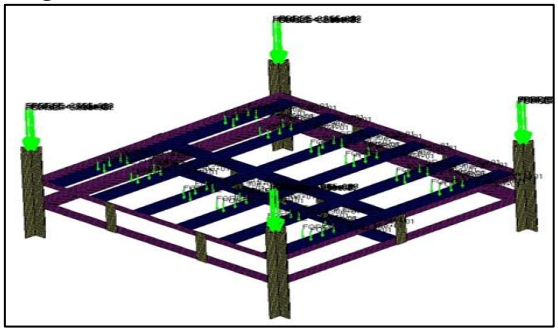

Fig. 3: 6 Engine block + self-weight is applied on the frame of the pallet as usual

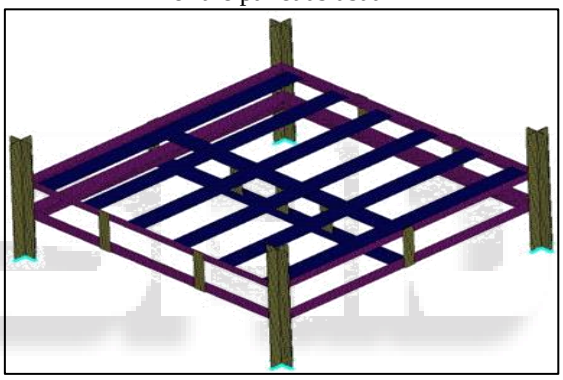

Fig. 4: Constraint at the bottom of 4 Legs

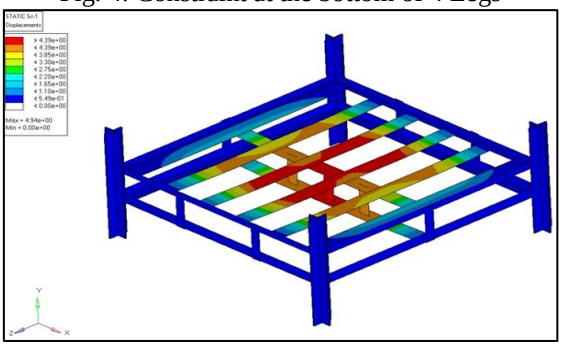

Fig. 5: Maximum Displacement = 5 mm

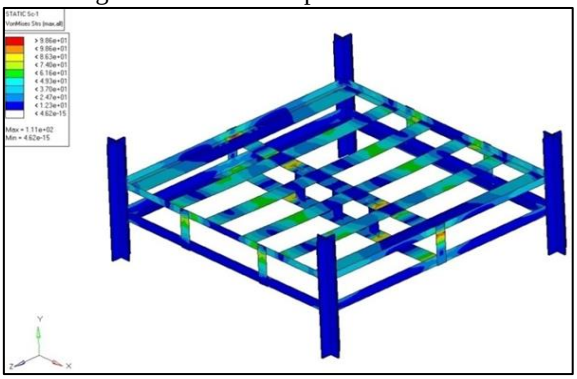

Fig. 6: Vonmises stress- 111Mpa

Since the induced Vonmises stress (111Mpa) is less than the Yield stress limit of 125 Mpa (Considering FOS as 2) for structural steel the design is safe, Also the stresses in 4 legs is very less (30Mpa).

IV. CONCLUSION

From the analysis result it is seen that the design of this pallet is safe to move the engine blocks from one place to another place and also safe in stacking form when we store engine blocks. Because its strength is very good. And the design intend considered for design of pallet meets all the acceptance criteria as per the functionality point of view under the safe working conditions. In the last the vonmises stress is less than the yield stress limit considering factor of safety as 2. Therefore we have to conclude that this type of pallet is safe.

REFERENCES

[1] Manoj P. Talele and Ashok J. Keche "Computer Aided Design and Experimental validation of Engine Metal Pallet", IJREAS, Vol. 5, ISSN 2249-3905, ISSUE 5(May, 2015).
[2] Manoj P. Talele and Ashok J. Keche, "Design Optimization and Simulation Study of the Engine Transportation Metal Pallet for Stationary and Movable Condition",http://dx.doi.org/10.14257/ijunesst.2015.8.5.20, vol.8, No.5 (2015), pp.219-230
[3] M.H.R. Godley, R.G. Beale and X. Feng, "Analysis and Design of Down-Aisle Pallet Rack Structures", ELSEVIER, Computers and structures 77 (2000) 391-40, www.elsevier.com/locate/compstruc
[4] Benoit P. Gilbert, Lip H. Teh, Romain X. Badet and Kim J.R. Rasmussen "Influence of Pallets on the behaviour and Design of Steel Drive-in Racks", ELSEVIER, Journal of constructional steel Research 97 (2014) 10-23
[5] Sourabh R. Dinde and Rajashekhar S. Talikoti, "Review Paper on Structural Behavior of Industrial Pallet Rack with Braced and Unbraced Frames". IJRET, Vol.-04, eISSN-2319-1163, pISSN: 2321-7308, Issue 03, March 2015
[6] E. Soury, A.H. Behravesh, E. Rouhani Esfahani and A. Zolfaghari, "Design, optimization and manufacturing of wood-plastic composite pallet", ELSEVIER, Materials and Design 30 (2009) 4183-4191
[7] Hande Yaman and Alper Sen, "Manufacturer's mixed pallet design problem", ELSEVIER, Science Direct, European Journal of Operational Research 186 (2008) 826-840
[8] Abdullah Waseem, Ahmad Nawaz, Nauman Munir, Bilal Islam and Sahar Noor "Comparative Analysis of different Materials for Pallet Design using ANSYS", IJMME-IJENS, Vol.-13, ISSN: 138002-6767, April 2013
[9] Rahul. V. Mahajan and S. T. Bagde, "Development of low cost Palletizing cell for handling different carton sizes" International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 10, October 2012)
[10] Pradip Vasantrao Kadam and N.V.Hargude, "A review on optimization of rotary table Pallets" international Journal of Mechanical Engineering and Technology (IJMET), ISSN 0976 – 6340(Print), ISSN 0976 – 6359 (Online) Volume 6, Issue 3, March (2015), pp. 21-24. © IAEME: www.iaeme.com/IJMET.asp Journal Impact Factor (2015): 8.8293 (Calculated by GISI), www.jifactor.com

