PROCESS & STRUCTURE OPTIMIZATION OF CONTROL PANELS TO ENHANCE THE PRODUCTIVITY RATE

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ABSTRACT

This report explores the application of feature based representation and design in the area of design for manufacturing to incorporate the tooling and process considerations into the early stage of design. The main aim of this research paper is to apply the concepts of feature based design and to develop an interactive design tool that can be used to alert designers to potential production problems, defects and errors, and to give them some information that can be used to create an alternative design, evaluate trade-offs and arrive at optimal designs for the given process conditions. Report illustrates the development of computer aided engineering system that was constructed using these concepts and applied to designing box type sheet metal parts. The stress and deflection analysis of old (traditional) structure is compared with new optimum design. The aim of the project is to optimize the structure design with respect to minimize the cost, number of manufacturing processes, process time, inventory and overall lead time.

Keyword: *Tooling, design, optimal, analysis, structure, minimize, manufacturing process.*

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1. INTRODUCTION

Sheet forming is a significant net shape manufacturing process of producing a large variety of consumer products (kitchen sinks, canes, cabinets, boxes, brackets, etc.) And aerospace parts (body panels, wing parts, etc.). Die design in sheet metal forming, even after many years of practice, still remains more of an art than a science. Historically the evolution of a sheet metal stamping from conception through part design to die design to the final die try-out has been a slow, cautious process based on the trial and error experience and skill of the artisan. Welding process after the sheet bending is more of the skill based work.

Prefabricated enclosure wall panel system belongs to a particular sub-category of Off-Site Manufacturing (OSM) construction systems, which are frequently used for economic and/or aesthetical reasons. However the technologies available for these systems have the potential to maximize the functional and constructional benefits of panelized fronts, thus contributing for the development of high-performance machine envelopes

1.1 Problem Statement

In an Industry, large numbers of control panel structures are manufactured in a year. Approximately 850-1000 Panels are manufactured annually. The panel design used presently is a traditional design which consists of complete use of sheet metal fabrication. The quality of panel depends on the labor skill in bending and welding. The aim of this project is to suggest process optimization considering following parameter:

1. Minimize the number of process
2. Minimize the time involve in material handling from one bay to another
3. Minimize the overall time required for panel building
4. Ease of fabrication
5. Standardization of sub parts
6. Maximize the output
7. Strength of panel should not be compromised
8. Quality of panel should not be compromised

1.2 Objectives

1. To suggest minimum two design solutions using modern techniques.
2. To do stress analysis of traditional structure and the new developed structure.
3. To increase the productivity.
4. To decrease the overall lead time of manufacturing.

1.3 Scope

The scope of this project is to make the 3D model of traditional panel structure. Study the processes used in manufacturing. Find the critical process with respect to time and cost. Redesign the panel structure using modern techniques and optimize the overall process. Compare the new design with the old one with help of stress and deflection analysis.

2 LITERATURE REVIEW

XiaobingDanga, et.al explained that incremental bending is a highly flexible forming method. It can be carried out by using more than one bending tool. Several strips can be bent simultaneously, which in turn, improves forming efficiency Two strategies can be adopted: one is unconstrained multiple tools bending and the other is constrained multiple tools bending. The constrained strategy would significantly reduce complexity of prototype. In constrained multiple tools bending strategy, the trajectory along the main strip is calculated according to minimum energy principle. [1].

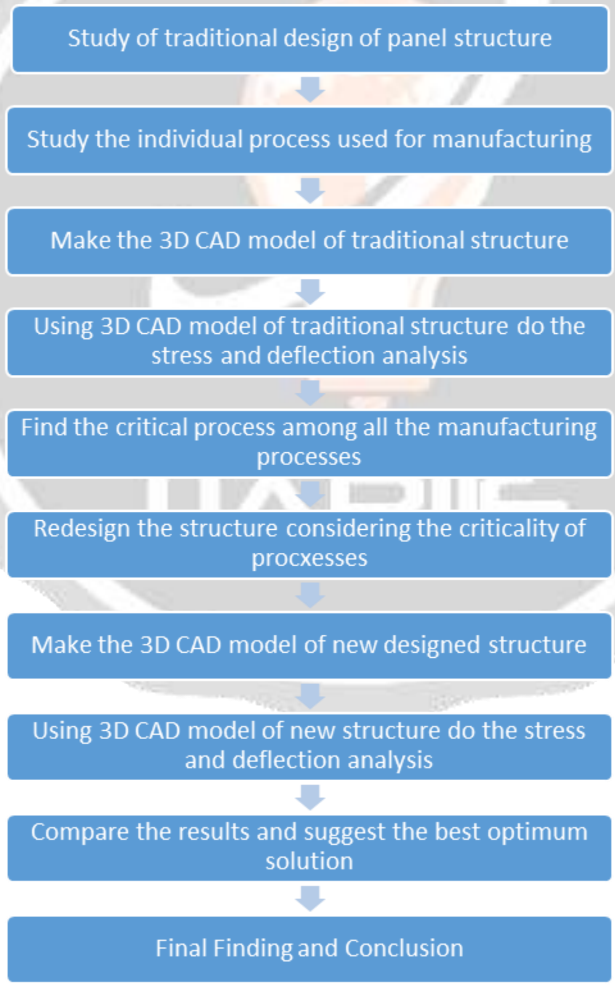
Hosein Moazamigoodarzi et.al explains that the temperature distribution and airflow inside an enclosed rack that is internally integrated with an RMCU. Experiments reveal effects due to passive servers, IT load density, IT load distribution and cold chamber depth that guide server configurations and rack geometry A new metric, *ASTD*, is enveloped to assess RMCU performance.The amount of required cold airflow per unit IT load in the enclosed rack integrated with an RMCU is up to fifty percent lower than required cold airflow for traditional cooling systems [2].

R. Mantripragada, et al tells us that features allow a structured representation of knowledge which can accommodate information about many aspects of the design in a common scheme. They allow the computer to capture and manipulate the design information and, ultimately, to make decisions. The CAE system developed can be used for formability analysis and design-for manufacturing analysis of box-type parts formed from sheet metal. [3].

Takashi Kuboki a, et.al explains that Incremental forming would have the potential ability of fabricating micro structural components. Saotome et al. developed a process called ‘‘incremental forming by hammering’’ for fabrication of micro structural chassis. Incidentally, incremental forming has been used for forming in ordinary scales as well. Matsubara controlled toll paths by computer numerical control [4].

Gonc¸aloCorreia Lopes, et.al explained that in a rigorous attempt to develop a systematic, logical and comprehensive framework to understand, evaluate and classify PEWPS, triggered by some incoherencies found in the literature [5].

3. METHODOLOGY



4. CONSTRUCTION AND DESIGN

4.1 Structure Description of Panel

Present structure is made of 2mm Mild Steel completely. Sheet metal is laser cut using laser cutting machine. Then the punching is done where ever required. Bending of individual part is done using bending machine. Individual part is manually checked for flatness. Then fabrication process starts which consists of welding grinding and finishing.

4.2 CAD Model of traditional Panel

We had used SolidWorks 2019 for 3D modeling of structure.

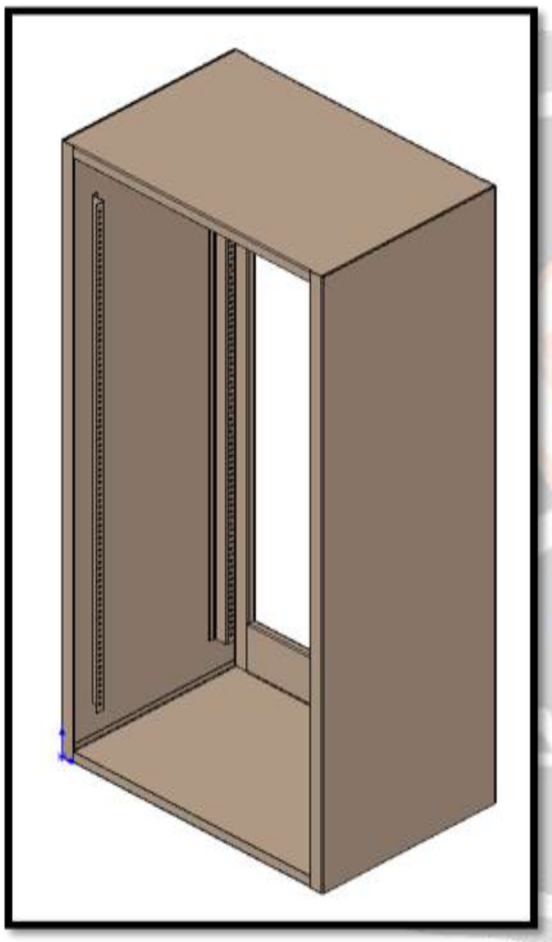


Fig-1: Present Structure (CAD)

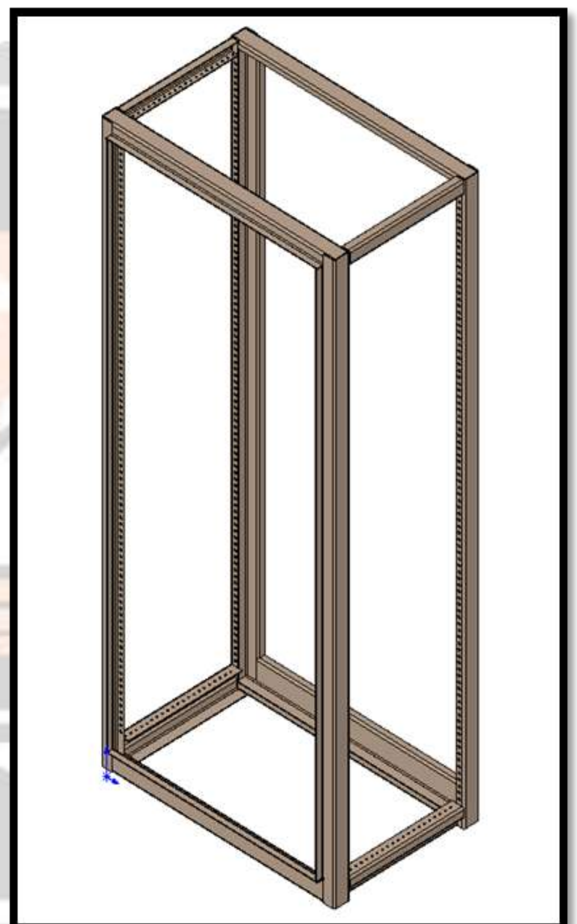


Fig-2: Designed Structure (CAD)

Mounting Bracket is the main part of structure. It is stitch welded with the side frame. This bracket carries the load from the mounting plate to structure frame. It is the first contact with the load. Welding of bracket plays an important role. The stitch welding is done in 200mm run.

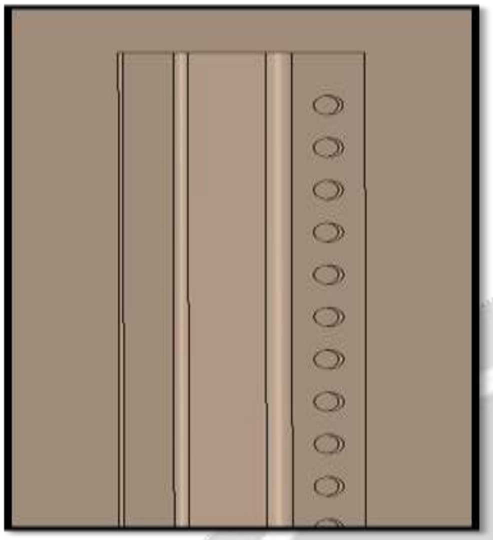


Fig-3: Present Mounting Bracket

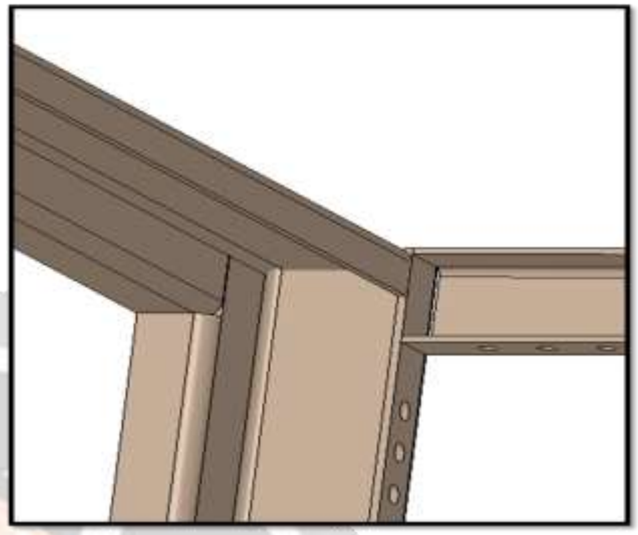


Fig-4: Designed Mounting Bracket (CAD)

5 FEA ANALYSIS

FEA analysis is done in simulation Add-on in Solidworks 2019. The analysis is done in Static mode.

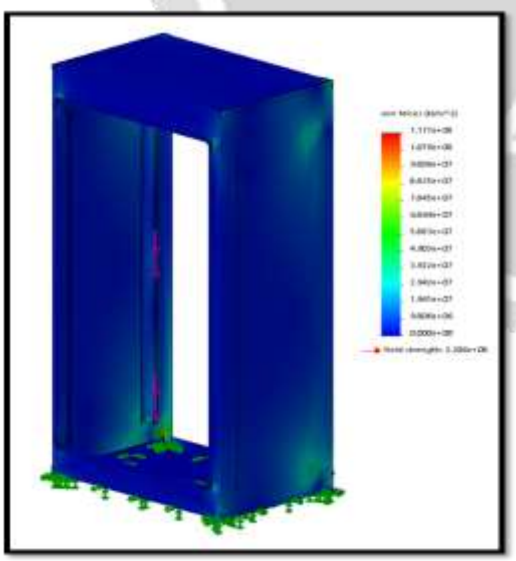


Fig-5: Stress Analysis Old Design

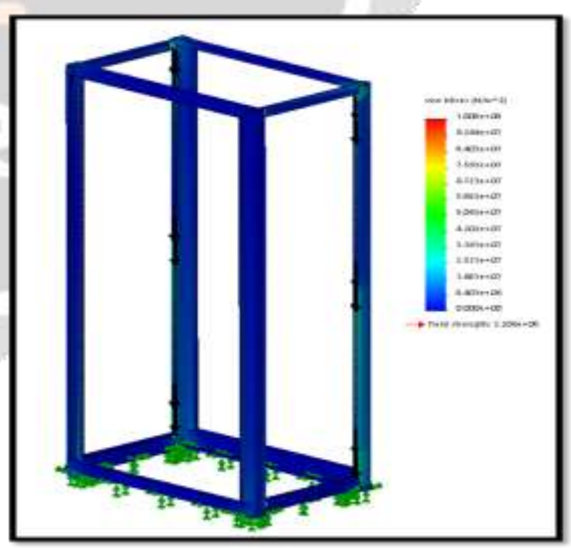


Fig-6: Stress Analysis New Design

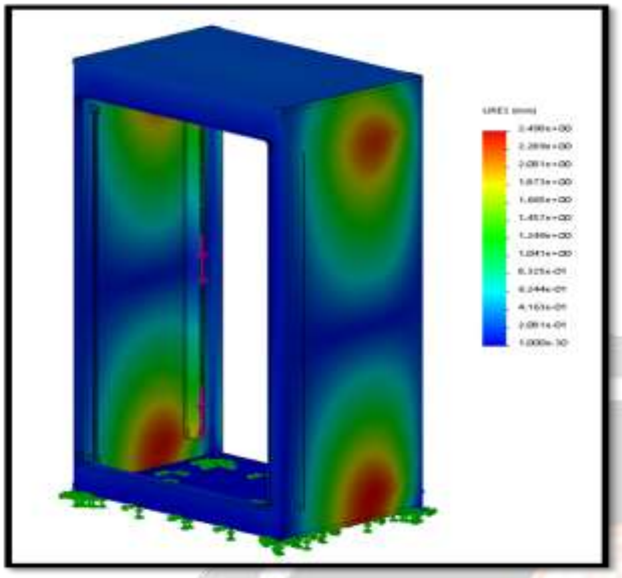


Fig-7: Displacement Analysis Old Design

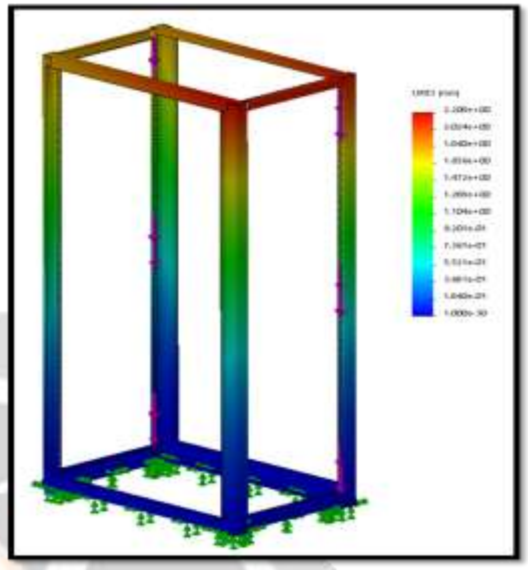


Fig-8: Displacement Analysis New Design

Fig-9: New Design (Actual)

5 RESULT AND DISCUSSION

From the analysis we found out the traditional structure can withstand the load which we have applied. The maximum stress which material can bear is the yield strength which is about 2.20594×10^8 N/m^2. The factor of safety we have obtained for load condition 2 which is maximum load is almost 2. Thus we can say the stress generated is within the limits. The displacement analysis shows that the maximum deformation which took place in the structure is at the bottom at the welding between the base sheet and the side sheet. The value of deformation is 2.5mm. From the result we can say that we have very narrow scope to reduce the stresses and the deflection. As the tradition panel is very functional from past many years we have great challenge in designing new model of control panel. The new design must withstand these same loading conditions and should perform better.

6 CONCLUSION

- The New Design of the control panel structure qualifies the dimensional and strength requirement of the industry.
- The Simulation proves the stresses generated are within the permissible limits.
- The Simulation proves that the deflection of new design is less than the tradition design.
- The inventory space required for part storage has been reduced due to frame type of structure.
- The movement of the parts has become easy due to reduces are of parts. Individual labor can carry 2 to 3 parts at a time, earlier minimum two labors were required for carrying 1 part.
- The throughput of overall plant has been increased from 4 panels per day to 7 panes per day.

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