Plan and Construction of Packet Holding Unit

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ABSTRCT: Our project is aluminum offset plate's carrier which consists of a hollow aluminum pipe frame. The L bend is welded at both the free end of the main frame. The frame is connected with the lower cross bar at the bottom end and the shoulder cross bar height. The bent hook is connected to the upper shoulder cross bar which locks into the shoulder. The wheels are connected to the bottom end of the frame so that we can carry the offset plates on horizontal surface. The flat load tray is hinged to the lower cross bar that rest on the free end of the L Bend. The Telescopic legs are provided that are inserted in the hollow main frame provided with side slot. This unit can be used carry the offset plates from one place to another on normal road and also in multiple floor building, thereby reducing the rejections through scuff and improper material handling.

Keywords: *offset plates, scuff and material handling*

1. INTRODUCTION

Offset printing is a commonly used printing technique in which the inked image is transferred (or "offset") from a plate to a rubber blanket, then to the printing surface. When used in combination with the lithographic process, which is based on the repulsion of oil and water, the offset technique employs a flat (planographic) image carrier on which the image to be printed obtains ink from ink rollers, while the non-printing area attracts a water-based film (called "fountain solution"), keeping the non-printing areas ink-free. The plates used in offset printing are thin, flexible, and usually larger than the paper size to be printed. Two main materials are used: Metal plates, usually aluminium, although sometimes they are made of multimetal, paper, or plastic Polyester plates are much cheaper and can be used in place of aluminium plates for smaller formats or medium quality jobs, as their dimensional stability is lower. This project is based on a material handling device which is specifically used to carry these aluminium offset plates from one place to another. The offset plates are used in offset printing industry. We have designed a unit which would help the workers to carry the offset plates easily without damaging the plates at the corners and due to abrasion and improper material handling thereby reducing the rejection of these plates.

The proposed objective of the project is as follows;

- To design and fabricate a model of a portable packet carrying unit which should carry the sensitive aluminium offset plates from one place to another.
- To design a compact structure or frame which should weigh around 3 kg and the time for loading or unloading of the plates and getting ready for transportation must be within 45 sec.
- The design of the unit must be such that the offset plates could be easily carried on ground (horizontal) surface as well as on multiple floors in the building. The total cost of the unit must be feasible.

2. METHODOLGOY

2.1 Operational Procedure

- **Understanding the problem faced by workers while carrying offset plates**

  It was observed that the offset plates were rejected due to improper handling of the plates by the workers. It was found that the workers were facing difficulty to carry heavy plates. Manual handling led to rejection of the plates.
- **Study of existing systems and products present in market**
  We studied about the existing material handling systems that are available in the market. The application of the product in real life and its constraints were understood.
- **Design thinking approach for a new product**
  Brainstorming and new ideas were developed by studying the drawbacks of the products.
- **Sketching down ideas on paper**
  Simple sketches and rough designs were executed which provided the basis for the further actual complex design in software
- **Designing a CAD Model**

Further tentative dimensions were finalized and CAD model was designed in Solid Edge v19. Here mechanisms that were thought during the design thinking were implemented. All the parts were designed and assembled together to make the final model.

- **Analysis on Ansys 19.0 Software**
  The model was imported to Ansys Software for FEA Analysis and for different material and loading the model was tested.
- **Fabrication of prototype and testing of prototype for given load condition**
  The prototype is manufactured and actual testing is done on the prototype and the results are noted.

2.2 Resourceful steps in the Invention

The packet carrying unit is used to carry offset printing plates used in offset printing. The present equipments can be used to carry square or rectangular boxes. The offset printing plates are very ductile and delicate. The maximum size of these offset plates is 1200*900*0.6 mm. The main purpose is to carry the packet of offset plates which weigh about 23 kg on horizontal ground as well as on the shoulder. We have also provided load tray attached to the cross bar which could be used to carry small and medium load.

The key inventive steps in our project are:

- We have provided telescopic legs with side slots to the main frame to lock the legs after extension and retrieval.
- We have managed to reduce or eliminate the extruded parts and tried to reduce the weight of the unit.
- We have made the wheel pair and the shoulder hook foldable so as to make the unit more compactable.
- The plates could be carried easily on horizontal surface and could be carried on shoulder with minimal stress on the body.
- Since we have provided load tray we can even use it to carry boxes and other products easily

2.3 Initial Design using Design thinking approach

Scuffing is a defect which occurs in offset printing plates, wherein the thermal sensitive coating is scraped off due to abrasion between the adjacent plates. Causes for scuffing are improper material handling, small grits in roller trains, transportation, manufacturing defects and packaging. The design of the packet carrying unit must be compliance to several aspects. The design consideration must be done carefully so that the design can be fabricated and the parts are all functioning. The aspects that are important for the designing are:

1) Strength: The design must withstand certain strengths like Tensile, shearing, compression and bending under the given load condition.

2) Ergonomics: the design was started with the basic study of the Human Anthropometry wherein the overall average measurement of the Human being was taken into consideration.

3) Mobility and compactness: The unit must be user friendly as easy and convenience. The unit must be compact to avoid occupying mire space and it should weigh less

2.4 Anthropometry

The scientific study of human measurement and proportion is called as Anthropometry. It plays an important role in the design aspect of the Packet Carrying Unit. The body measurement of workers varies from person to person. Thus by considering the average Indian measurement of a person, we have designed some of the critical parts of the unit.

The standard measurements are:

Average Height of the person = 5 feet 3 inch (1600 mm)

Average Arm length = 720 mm

Average shoulder length = 450 mm

Average neck size = 200 mm

Average elbow lift = 425 mm

2.5 Sketching

We started working on the design with simple sketch and patterns that are executable. It is an iterative process where small mechanisms and overall structure was designed on frame, basic sketch and lever mechanism

2.5 3D CAD Model

After the sketches have been selected, the next step in the designing process is dimensioning. The dimensioning is base on relevant dimensions and also referring to the anthropometry details so that the design is fit into others part. After dimensioning, the engineering drawing of the design is drawn using Solid edge v19 application; at this stage solid modelling method is used. Part by part solid modelling created according to the dimension done before, after all part created, the 3D model is assembled with each other base on the design.

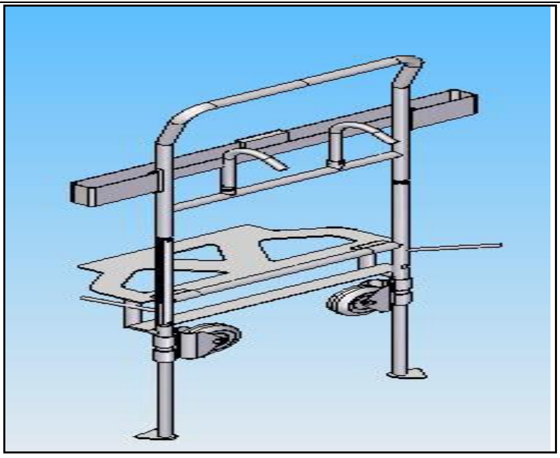

Figure 1. Isometric View

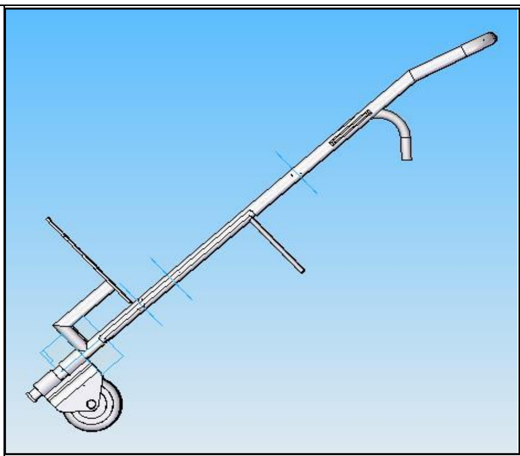

Figure 2. Front 45

2.5 Calculations

The static analysis is applied when the value of any load acting on frame does not change with time. Generally linear behaving materials are used for manufacturing of frames. Thus the structural welded base frame structure was subjected to linear static analysis. The material used is structural Mild steel.

2.5.1 Calculations of Hook (Fig.3)

a) The area of section

$$A=\frac{\pi}{4}\times(d_1^2-d_2^2)$$

$$=\frac{\pi}{4}\times(23^2-21^2)$$

$$=69.11\ mm^2$$

b) Distance from centroidal axis to neutral axis (e)

$$e = R - R_n = R - \frac{0.5\,(r_1^2 - r_2^2)}{\sqrt{R^2 - r_2^2} - \sqrt{R^2 - r_1^2}}$$

c) Radius of curvature

$$R = 47 + \frac{23}{2}$$

$$= 58.5\text{mm}$$

From DDHB,

$$e = R - R_n = R - \frac{0.5(r_1^2 - r_2^2)}{\sqrt{R^2 - r_2^2) } - \sqrt{R^2 - r_1^2}}$$

$$e = 58.5 - \frac{0.5(11.5^2 - 10.5^2)}{\sqrt{58.5^2 - 10.5^2} - \sqrt{58.5^2 - 11.8^2}}$$

$$= 58.5 - \frac{0.5(22)}{\sqrt{57.55 - 57.35}}$$

$$= 58.5 - \frac{11}{0.193}$$

$$= 58.5 - 56.99$$

$$e = 0.61\text{mm}$$

d) Moment

$$M = W \times R$$

$$= 125 \times 58.5$$

$$= 7312.5\text{N}$$

e)Neutral Axis

$$Rn = R - e$$

$$Rn = 58.5 - 0.61$$

$$= 57.89mm$$

f) Direct Stress

$$\sigma_t = \frac{W}{\frac{\pi}{4}(23^2 - 21^2)}$$

$$\sigma_t = \frac{125}{\frac{\pi}{4}(23^2 - 21^2)}$$

$$= 1.8N/mm^2$$

g) Bending Stress

$$\sigma = \frac{My}{A \times e \times R}$$

$$\sigma_{bi} = \frac{7312.5 \times 10.9}{69.11 \times 0.60 \times 47}$$

$$= 40.88 \text{ Mpa}$$

$$\sigma_{b0} = \frac{7312.5 \times 7.1}{69.11 \times 0.60 \times 65}$$

$$= 19.26 \text{ Mpa}$$

$$Yi = Rn - Ri$$

$$= 57.9 - 47$$

$$= 10.9mm$$

$$Yo = 65 - 57$$

$$= 7.1mm$$

h) Resultant stress at inside fiber

$\sigma_t + \sigma_{bi}$

$= 1.8 + 40.88$

$= 42.68$Mpa (tensile)

$\sigma_t - \sigma_{bo}$

$= 1.8 - 19.26$

$= - 17.46$

$= 17.46$ (compression)

2.5.2 U shape calculations (Fig.4a&b)

Moment for UDL cantilever Beam

$$M = \frac{wl^2}{2}$$

$$M = \frac{2 \times 60^2}{2}$$

$$M = 3600\text{N-mm}$$

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

$$\sigma_b = \frac{M \times y}{I}$$

$$= \frac{3600 \times 12.5}{\frac{\pi}{64}(25^4 - 21^4)}$$

$$\sigma_b = 4.673\ N/mm^2$$

$$\text{Deflection} = \frac{Wl^3}{8EI}$$

$$= \frac{2 \times 60^3}{8 \times 80 \times 10^3 \times \frac{\pi}{64}(25^4 - 21^4)}$$

$$= 0.070 \times 10^{-3} mm$$

2.5.3 Shearing stress on Pin (Fig 5)

$$\tau_s = \frac{F}{A}$$

$$\tau_s = \frac{125}{\frac{\pi}{4} \times 8^2}$$

$$\tau_s = 2.45 \text{ N}/mm^2$$

Double shear

$$\tau_s = 2.45 \times 2$$

$$\tau_s = 4.97 \text{ N}/mm^2$$

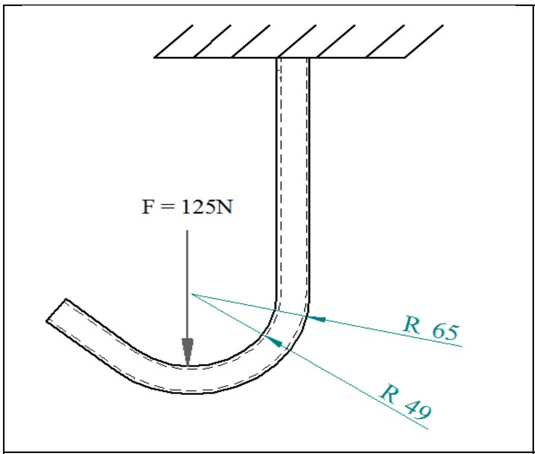

Figure 3. Hook

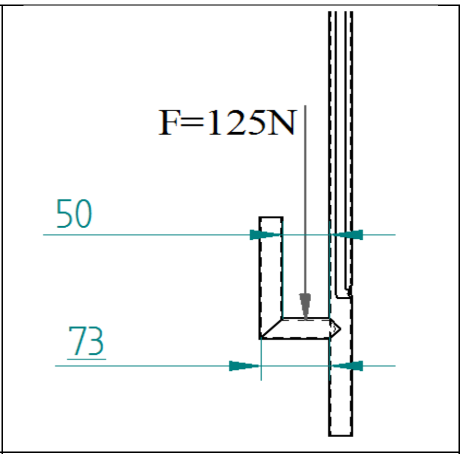

Figure 4a. Main Frame

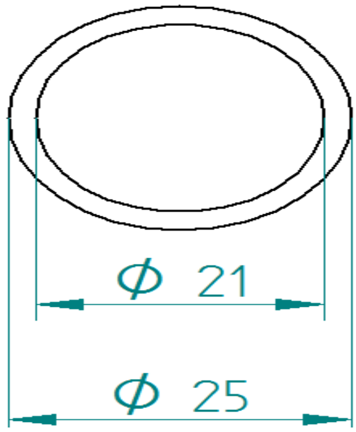

Figure 4b. Cross sectional view

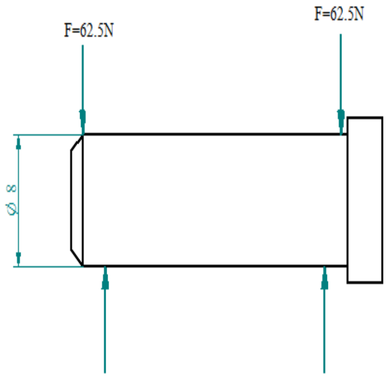

Figure 5. Pin

3. RESULTS

3.1 Analysis on ANSYS 19.0

3.2 Comparison with different material

The material selection is a crucial aspect which is to be considered before manufacturing of the actual prototype. This table provides the properties of different material.

Topic	**M.S**	**Aluminium**	**Epoxy Carbon Fibre Unidirectional**
Youngs Modulus	2×1011 Pa	7.1×1010 Pa	220 Gpa
Shear Modulus	7.7×1010 Pa	2.7×1010 Pa	----
Bulk Modulus	1.67×1011 Pa	6.96×1010 Pa	----
Density	7850 $Kg/m3$	2770 $Kg/m3$	1800 $Kg/m3$
Yield Strength	2.5×108 Pa	2.8×108 Pa	----
Ultimate Strength	4.6×108 Pa	3.1×108 Pa	8.618×108 Pa

Table 1. Properties of Material

Analysis of the important parts on Ansys 19.0

1) Main frame

Parameter	**Aluminium 6061**	**Epoxy carbon fiber pipe**
Von mises stress in MPa	3.8	31.24
strain	.0000675	0.0012
Total deformation in mm	0.5	9

Table 2. ANSYS Results

2) Hook

Parameter	**Aluminium 6061**	**Epoxy carbon fiber pipe**
Von mises stress in MPa	53.59	79
strain	.00083	0.0045
Total deformation in mm	1.46	8

Table 3. ANSYS Results

3) Load tray

Parameter	Aluminium 6061	Epoxy carbon fiber pipe
Von mises stress in MPa	43.93	18.327
strain	.00065	.006
Total deformation in mm	4.6	1.89
Factor of Safety	6.4	

Table 4. ANSYS Results

Comparison on weight and cost of the unit:

Sl no	Material	Total weight (approx) in Kg	Material cost in Rs
1	Mild steel	7	315.00
2	Aluminium alloy 6061	3.5	700
3	Epoxy carbon fibre 390	2	14000

Table 5. Comparison of the material cost

3.3 Caster wheel

A caster is a wheeled device typically mounted to a larger object that enables relatively easy rolling movement of the object. Casters are essentially housings that include a wheel and a mounting to install the caster to objects (equipment, apparatus and more).

Caster wheel specification:

1) Diameter of the wheel = 6 inches (150 mm)

2) Width of the wheel = 1 inch (25.4 mm)

3) Load carrying capacity = 50 kg

4) Material of the wheel = Polyethylene (fiber)

3.4 Fabrication of the Prototype

After finalizing CAD model, 2D drawings of individual part are plotted and according to the drawings material procurement for fabrication is done. After material procurement, the marking and cutting of pipes was done for further operations.

a) Bending Process

Bending is a process by which metal can be deformed by plastically deforming the material and changing its shape. The material is stressed beyond the yield strength but below the ultimate tensile strength. The surface area of the material does not change much. Bending usually refers to deformation about one axis.

Bending process started with filling sand into the pipe and then sealing both ends of the pipe. This is done to prevent the dents occurring on the pipe surface while bending. While bending the portion of bend is heated slightly to perform the operation smoothly and with damaging the pipe. The pipe is bent at angle of 130^0.

a) Drilling

Drilling is easily the most common machining process. One estimate is that 75% of all metal-cutting material removed comes from drilling operations. Drilling involves the creation of holes that are right circular cylinders. This is accomplished most typically by using a twist drill, something most readers will have seen before. The chips must exit through the flutes to the outside of the tool. As can be seen in the figure, the cutting front is embedded within the work piece, making cooling difficult. The cutting area can be flooded, coolant spray mist can be applied, or coolant can be delivered through the drill bit shaft.

Drilling Operations performed are:

Sl no	Operation	Part name	Dimensions	Tool used
1.	Linear slotting	Main body frame	Length=425mm Width =8mm	Reamer
2.	Through Drilling	Upper crossbar	$\emptyset 8mm$	Twist drill
3.	Through Drilling	Hook	$\emptyset 8mm$	Twist drill

Table 6. Drilling Operation

3.5 Tungsten inert gas (TIG) welding

This is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area and electrode is protected from oxidation or other atmospheric contamination by an inert shielding gas(argon or helium), and a filler metal is normally used, though some welds, known as autogenous welds, do not require it. When helium is used, this is known as heliarc welding. A constant current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionized gas and metal vapors known as plasma.

Specifications

Regulator = Single flow tube

Cooling type = Gas cooled torches

Base metal = mild steel

Welding current= Direct current straight polarity

Welding ampere = 80-100

Shielding gas = 75% Argon, 25% Helium

Electrode = 2% Ceriated (EW-Ce2)

3.6 Prototype of the "Packet Carrying Unit"

Figure 6. Packet Carrying Unit

4. DISCUSSION AND CONCLUSION

After manufacturing the prototype it was tested by carrying a load of 25kg on horizontal surface as well as climbing the stairs by carrying it on shoulder. It was found out that the plates were not damaged. Apart from carrying offset plates, the unit can carry medium size boxes. Hence we conclude that the design is safe and this unit provided an easy material handling without much stress on human body. So for in future the same project will be designed first step with by selecting lower density material may possibly used instead of mild steel for weight reduction. We can use Aluminum or Carbon fibre considering cost of the material into account. Second step with by improving in the mechanism that instead of latching system roller system can be used to minimize the complexity of the locking system. Third step with by improving in cushioning, so that we can increase the comfort by adding rubber pads and cotton belts and finally last step is compact design could be made more compact by folding the unit into half so that it should occupy less space.

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