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Design and Fabrication of Portable Luggage Cart

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Abstract: ***Luggage is an intrinsic part of travelling. If it is heavy, carrying luggage is a difficult task for anyone. There are many inventions made to resolve this issue. People use various trolley bags to carry luggage. But the price of trolley bags are little higher and cannot be afford by everyone. A portable luggage cart is the best solution to this problem. It is simple and can carry up to 150 kg. It is designed in such a manner that it can be placed in a bag. When it is unfolded the size becomes double. The present work concentrates on design of portable luggage cart and fabrication of the same. Four caster wheels are provided to increase the stability of cart. The cart is designed in CATIA and later equivalent stress and total deformation of design are calculated by using ANSYS. A prototype of the design was produced by using additive manufacturing technique. A STRATASYS 3D printer [FDM (Fusion Deposition Modeling) based)] is used to prepare prototype. Aluminum bars are used to prepare actual cart due to its low density. The final cart is fabricated by using basic mechanical operations like cutting, slotting, fitting and broaching. These carts will reduce the congestion in railway stations and bus stations by increasing the speed of movement of passengers.***

Keywords **: Portable luggage cart, Caster wheels, Equivalent stress, Fusion Deposition Modeling.**

I. INTRODUCTION

Travelling is a regular phenomenon of humankind. Luggage is an important aspect of travelling. Every day millions of people travel in India as well as in world. Carrying luggage is a difficult activity of travelling. Especially in India people used to carry lot of baggage along with them. People use various trolley bags to carry luggage, whose cost is little higher. The idea of portable luggage cart is mainly cater the need of people who are not able to afford costly trolley bags and also the people who wants to carry luggage with little effort. In the present paper we will design cart, analyze the cart and finally fabrication of the cart. This cart can be used in Railway stations and Bus stations to increase the movement of passengers by reducing the impact of carrying luggage.

II. LITERATURE SURVEY

Luggage carrying cart design needs to consider factors such as weight, size, aesthetic aspects etc.

Raj Kumar *et al*. [1], designed a universal trolley carrier with stair climbing mechanism using trilobe assembly. The materials were Aluminum, PET (Poly Ethylene Terephthalate) and ABS (Acrylonitrile Butadiene Styrene). Main focus of the work was cart dimensioning and material selection. These trolleys are used for climbing steps, but, limited to carry one bag. Wasnik *et al.* [2], worked to increase the carrying capacity of cart by attaching an extra wheel to the cart. A motor and dynamo attached to the wheel by using bevel gear mechanism. They mainly concentrated on increase carrying capacity. Al Sult Al Kharusi *et al.* [3], designed an electrically operated multipurpose trolley in which they designed industrial trolley which can be used to transfer luggage or items from one place to another place. They used electric power supply for the trolley. The cost of this equipment is very high; moreover, it is not portable.

III. METHODOLOGY

Four steps are involved in the project. They are mentioned in the following flow chart (Fig. 1).

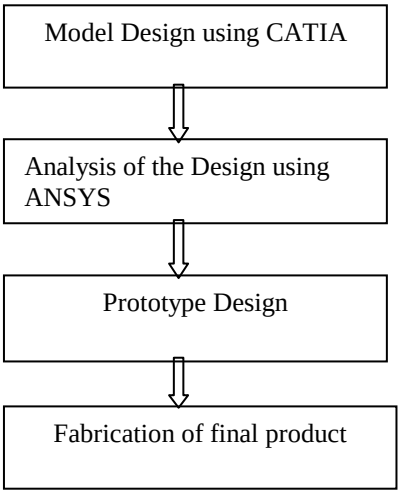

Fig. 1

A. *Model Design using CATIA*

The cart is designed in CATIA (Computer Aided Three Dimensional Interactive Application). CATIA V5 soft ware is used to create three dimensional shapes directly from a two dimensional drawing. The cart is equipped with the use of hollow bars that can be extended when desired. The same feature is used to design Trolley handle. The base plate (Fig.2) dimensions are (in mm) of 400×300 and width of the frame is 30 mm and the plate thickness is 2mm.

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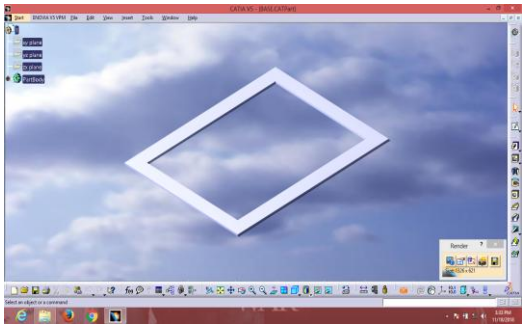

Fig.2 Base plate

There are four horizontal hallow bars of length 400mm and square cross-section of side 30mm and has groove(along center line of bar) of 12mm in each bar as shown in Fig. 3. Two vertical bars of same dimensions are fixed as handles. A bar of length 200mm of square cross section of side 20mm is inserted in each bar. A bar of length 400 mm and square cross-section of side 20mm is inserted in handle grooved bar.

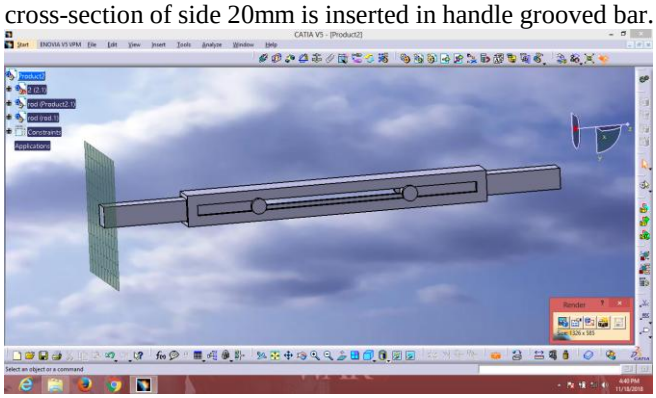

Fig.3 Grooved Bar

Four wheels are placed, one at each corner of the base plate with equal distance from center of gravity. The proposed wheels are Caster Wheels as shown in fig 4. These wheels can rotate 360^{o}. The wheel diameter is 50mm and thickness is 25mm.

Fig.4 Caster Wheel

B. *Analysis of design using ANSYS*

Analysis of the design carried out in ANSYS V15 workbench. Aluminum was used as model material.

Equivalent (Von-Mises) stress is calculated since frame goes under simple tension i.e., static load will act on the frame. Yield criteria have taken into consideration and we have taken Aluminum yield strength as 60 MPa. Factor of safety is calculated based upon ANSYS results. Total deformation of design was calculated to check the ground clearance. By varying the loads 3000N, 2000N and 1000N we calculated equivalent stresses (Fig.5) and total deformation (Fig 6).

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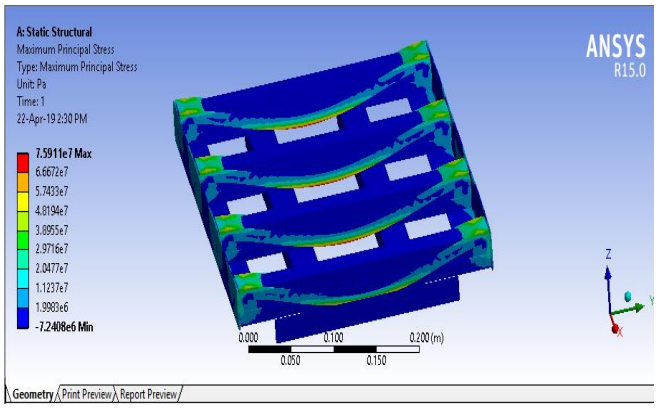

Fig.5 Equivalent stress at 3000N

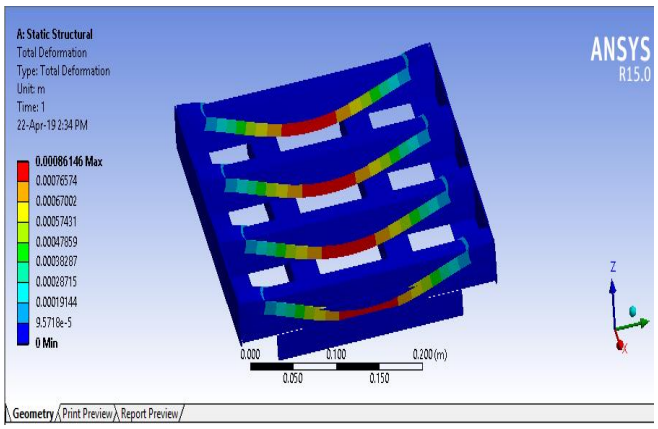

Fig.6 Total deformation at 3000N

C. *Building of Prototype*

A Prototype (Fig.7) of the given design is prepared by using STRATASYS UPLUS 3D Printer. FDM (Fusion Deposition Modeling) process is used to print the given design. ABS material is used to print the prototype. The main aim of designing of prototype is to check arrangement of bars in the handle and frame. Initially a grove has given in the handle bar to extend internal bar but after 3D printing we came to know that groove is not suitable for handle. We replaced groove with full size bar with a stopper mechanism at the end of the bar. Since, the maximum build size of equipment is 203 × 203 × 152 (All dimensions are in mm), the actual design is reduced with same proportions.

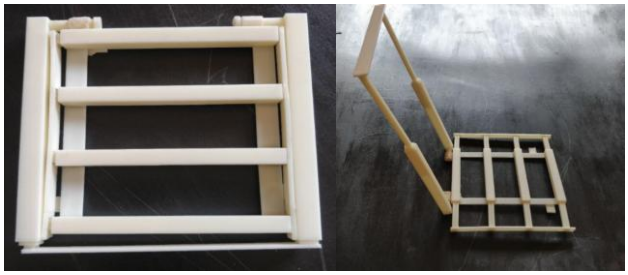

Fig.7 Cart Prototype

D. Fabrication

Based upon the design dimensions square aluminum hollow bars of different sides of 30mm and 20mm are used for construction of proposed cart. By applying cutting, fitting and drilling operations the portable luggage cart was fabricated.

Fig 8: Aluminum bars of size 20×20 and 30×30

TABLE-I: Detailed description of each part in the cart

S.NO	Part Name	Dimensions (in mm)	Quantity	Weight (in Kg)
1	Frame	400×300 Width=30 Thickness=2	1	0.10560
2	External Horizontal bars	30×30 Length=300 Groove =12	4	0.94248
3	Internal Horizontal Bars	20×20 Length=150	8	0.36960
4	External Vertical bars	30×30 Length=400	2	0.36960
5	Internal Vertical bars	20×20 Length=400	2	0.24640
6	Handle	30×30 Length=430	1	0.19866
7	Handle (Internal)	20×20 Length=430	1	0.13244
8	Caster Wheels	Diameter=50 Thickness =25	4	0.20000
9	Clamps	30×30	11	0.11434
	Total Weight			**2.74662**

IV. RESULTS

The final design dimensions are 430mm ×360mm×100mm in folded condition (Fig.7). When it is unfolded (Fig.8) it occupies an area of 800mm × 600mm which can be utilized as carrying space. The handle can be extended up to 860mm so that one can pull the trolley with less effort.

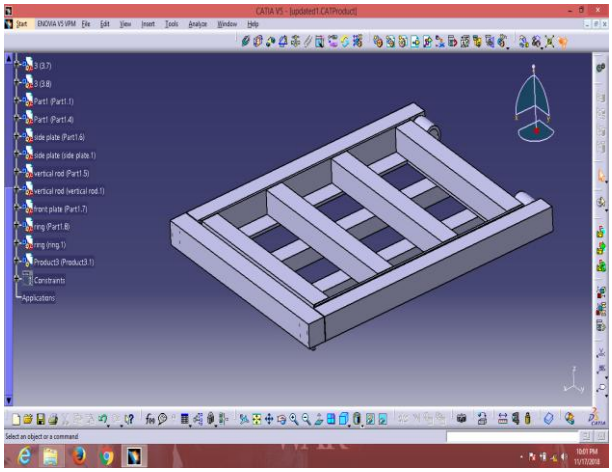

Fig. 9: Cart frame folded position

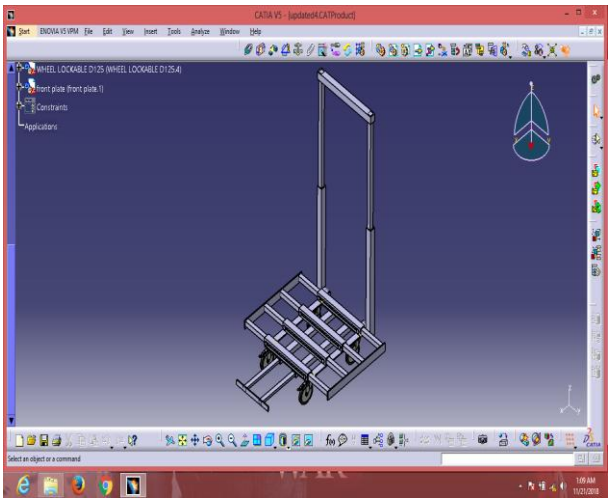

Fig.10: Cart Unfolded

The analysis of cart design at various loads gives the following results as mentioned in Table II. Factor of safety is calculated by standard value of Yield strength of Aluminum i.e., 60 MPa.

TABLE-II: ANSYS Results of Cart

LOAD (in N)	EQUIVALENT STRESS (in MPa)	TOTAL DEFORMATION (in mm)	FACTOR OF SAFETY
3000	75.91	0.86146	0.79
2000	59.99	0.63791	1.001
1000	41.96	0.25844	1.46

We will consider a safe factor of safety as 1.46 and the final fabricated cart is suitable to carry a load of 1000N i.e., maximum up to 100 kg. The density of Aluminum is 2.75g/cc, and the weight of the designed cart is 2.746 kg only. This facilitates the portability of the cart. The final fabricated cart is shown in the Fig.11. In the final design of cart a tarpaulin canvas attached to the frame to carry small objects also.

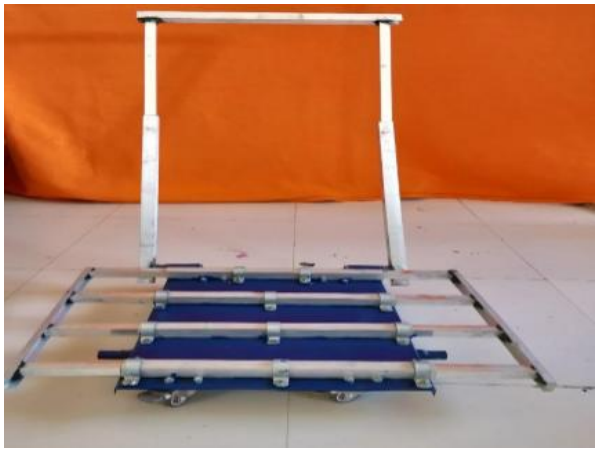

Fig. 11: Fabricated final portable luggage cart

The cost of final cart is Rs.725 only, which is much cheaper than many luggage trolleys in the market more over it, is portable also. It can be folded in a bag. Table III gives the cost details of the cart.

TABLE III: Cost details of the cart

S.NO	Item	Quantity	Cost/item or Kg	Total cost (Rs.)
1	Aluminum 6061 Square Bars	3kg	150	450
2	Caster Wheels	4 Nos	40	160
3	Tarpaulin Canvas	0.12m^2	60	60
4	Clamps	11	5	55
Total Cost(in Rupees)				725

V. CONCLUSIONS

Carrying luggage is definitely a problem to everyone. People are searching for various solutions to overcome it. In a country like India people give more preference to the price. And a portable luggage carrier is the best economical design to overcome the problem of luggage carrying. Aluminum is used to fabricate the cart which reduced cart weight enormously. The analysis results show that it can bear a load up to 100kg. Not limited to carrying luggage, it can be used in transport industries for lighter goods. A mechanism of robotic line sensing motor ridden caster wheel can be used in the cart and it can be used for faster passenger movement in airports to reduce congestion.

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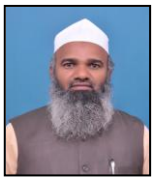

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