International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 10 | Oct -2016 www.irjet.net p-ISSN: 2395-0072

"DESIGN AND FABRICATION OF COMPACT FOLDABLE LADDER"

Mohammadtabrej Nakum[1], Raj Kansagara[2], Kishan Chovatiya[3], Avesh Khan[4]

[1]B.E student, Parul Institute of Engineering And Technology,Limda(India)
[2]B.E student, Parul Institute of Engineering And Technology,Limda(India)
[3]B.E student, Parul Institute of Engineering And Technology,Limda(India)
[4]Assitant Professor, Parul Institute of Engineering And Technology,Limda(India)

Abstract - *The ladder is among the equipment that helps to carry out different work process in ease manner at various industrial as well as residential areas. This paper is based on the design and fabrication of a compact and foldable ladder that serves multiple purposes to overcome the limitations of current ladder design. The ladder so formed by the modifications proposed by us will not only perform the basic functions but also can be used for material handling purpose. Thus we propose to design and fabricate a light weight, compact and portable multipurpose ladder .The ladder available in the local market are heavy, requires a lot of space, serves a single purpose and are not as stable as they should be. The whole project involved various methods like concept design, system design followed by fabrication and testing. Testing was carried out at various locations so as to make sure that the product is functional and achieves the targeted objectives successfully.*

Key Words: **Ladder, Hinge lock, pin, Braces, Rungs, Slope, Plate, Caster, Frame.**

1. Introduction

A ladder is a steps consisting of two parallel members connected by rungs; for climbing up or down. It has ascending stages by which the user can climb as well shift heavy loads using the ladder. There are two basic types of ladder, rigid ladder and rope ladder, rigid ladder is the one that can be slandered against a vertical surface such as a wall while rope ladders are the ones that can be hung. The vertical members of a ladder are usually called beams or stiles. Rigid ladders are usually portable, but sometimes they are permanently fixed to buildings.

1.1 Types of ladders

1. Fixed ladder
2. Step ladder
3. Orchard ladder
4. Telescopic ladder
5. Hook ladder
6. Extension ladder

1.2 Specific requirements which the above mentioned systems cannot fulfill completely.

1. Height needs to be adjustable.
2. Should be easily foldable.
3. Easy to port and store.
4. Can be used for high place maintenance job.
5. Easy to lift
6. Higher load carrying capacity (around 150kg).
6. Minimum cost.
7. Easy material loading and unloading.
8. Can be converted into a slope for material unloading.
9. Can be converted into a trolley for material transfer.

2. Proposed Design

The above mentioned requirements can be fulfilled by using a compact foldable multipurpose ladder which uses six long and same sized braces (rectangular cross section) with another small channels (square cross section, separated by the required distance) for developing the ladder. There are three different parts in which each part is made of two long braces and six small rungs (perpendicular to braces). All three parts are connected with hinges and door latch type locks, to make the ladder foldable. A plate is attached to each part on one side for a slope. Casters are used in order to make it work like a trolley when required.

2.1 Design over view

The computer aided design software Creo-2.0 was used to make the detailed design for analyzing and manufacturing the product.

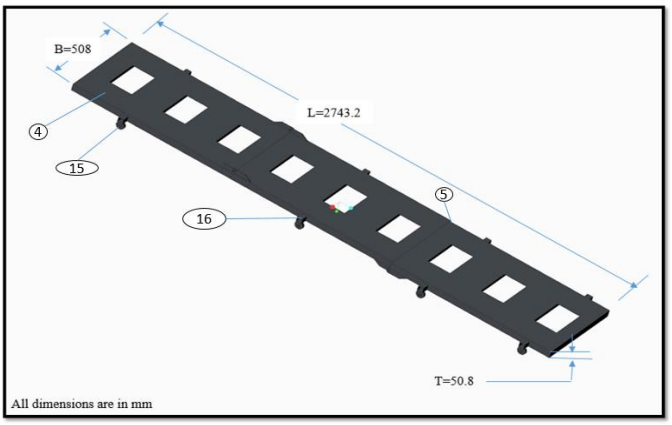

Fig -1: Model Used as Slope (fully open condition)/ Fully Open trolley

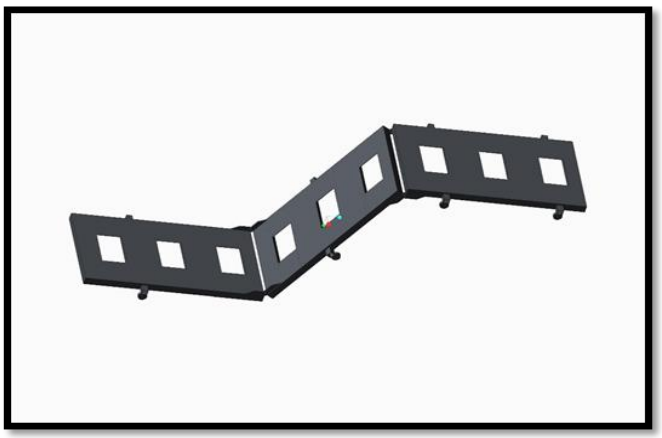

Fig-1.3: Model in Folding Condition

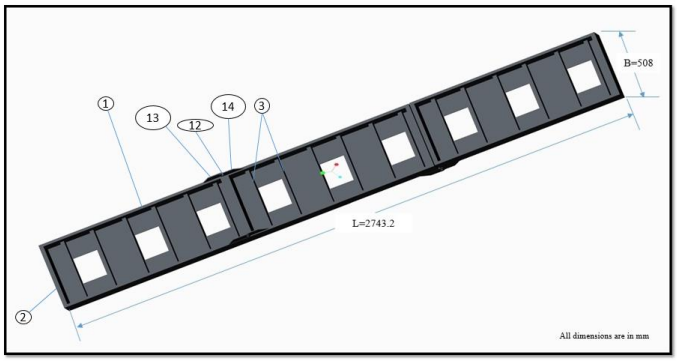

Fig -1.1: Model Used as Ladder (fully open condition)

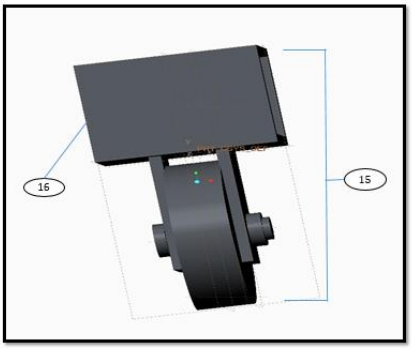

Fig-1.4 Caster System

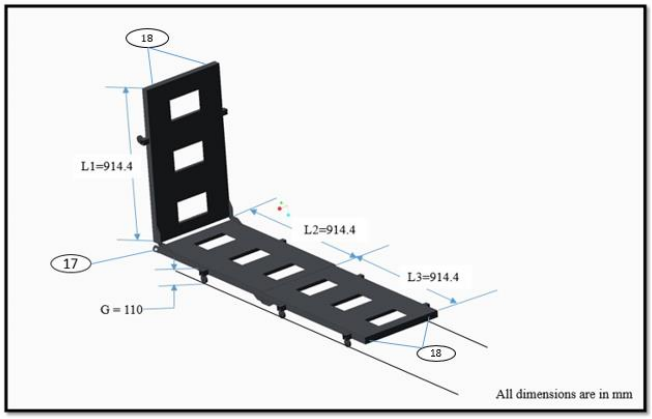

Fig-1.2: Model Work as Trolley

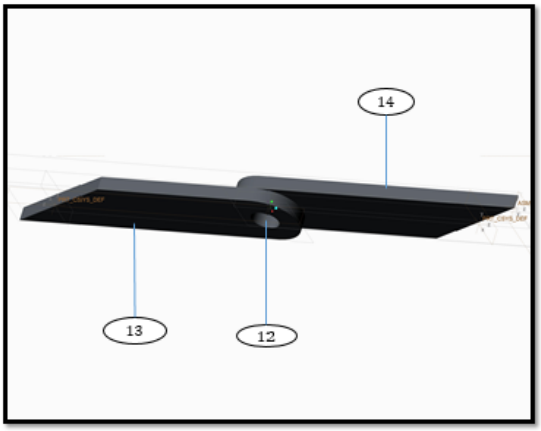

Fig-1.5 Hinge System

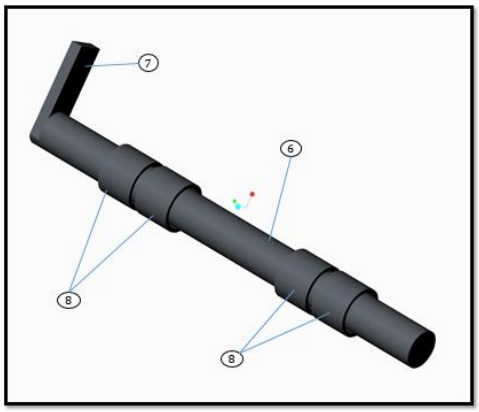

Fig-1.6 Door latch type lock system

Table -1: Parts used in the Ladder.

Sr No.	Part	Material	Quantity
1	Long Braces(Channel)	Mild steel	6
2	Short Braces(Channel)	Mild steel	6
3	Rungs	Mild steel	18
4	Plates(3 Rectangular holes inside)	GI Sheet	3
5	Door and latch type lock system	Mild steel	4
6	Lock Rod	Mild steel	4
7	Lock Rod Handle	Mild steel	4
8	Lock Ring	Mild steel	16
9	Lock Stop (Top)	Mild steel	4
10	Lock Stop (Bottom)	Mild steel	1
11	Hinge System	Mild steel	4
12	Hinge Pin	Mild steel	4
13	Hinge Part[1]	Mild Steel	4
14	Hinge Part[2]	Mild steel	4
15	Caster System	As per Catalogue	8
16	Mounting Brackets for caster	Mild steel	8
17	90° Lock Female Part	Mild steel	2
18	Rubber Friction Pads	Synthetic rubber	4

3. Fabrication Process

On the bases of computer aided design and prototype, Fabrication process was done in local fabrication shop.

3.1 Prototype generation

On the bases of prior product designs, dimensions were selected. The prototype was made using a thermocol sheet.

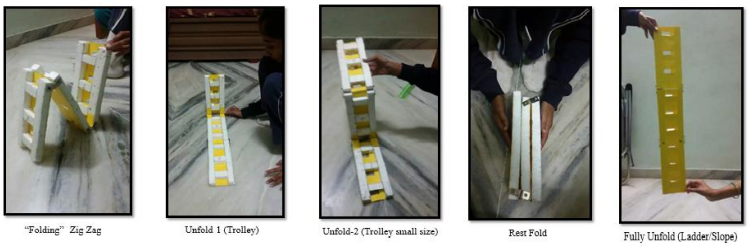

Fig-2 steps involved in prototype generation

3.2 Frame generation

Considering the total height of ladder as 9 feet and divided into three sections as discussed previously, three folds were required to serve the purpose. So each section happens to be 3 feet in length and 20 inches in width (from the reference of prior product design).Long braces and short braces were made from rectangular hollow pipe (2*1 inch, from the reference of prior product design) Welding process used: MIG

Fig-3 Frame generation

3.3 Hinge fitting

After frame generation, hinges were used to connect two different rectangular hollow parts of frame. Total four hinges were used to connect 3 parts of frame.
Hinges were fabricated as per the prior product design.

Fig-4 Hinge fitting

3.4 Plate development

Three different GI sheet plates with same dimensions were fabricated with the help of cutter and grinding machine. Each sheet had same dimensions as that of each section. Three rectangular holes (8*5 inch) were made as shown in the Fig.5 in order to provide a clearance on the rungs for a better foot placement without affecting the front face which can also be used as a slope depending upon the application.
Length=36”
Width=20”

Fig-5 Plate development

3.5 Plate fitting

In this process, further developed plates were welded (MIG welding) on respective frames.

Fig-6 Plate fitting

3.6 Locking system

To enhance high load carrying capacity door latch type locking was fabricated (according to standard lock system) and fitted on both side of frame near hinges in fabrication shop.

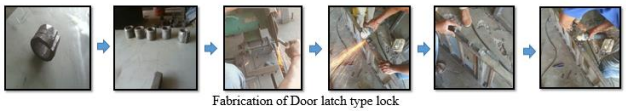

Fig-7 Fabrication of door latch type lock

3.7 Caster fitting

A swivel caster incorporates a wheel mounted to a fork with an additional swivel joint above the fork allows the fork to freely rotate about 360°, thus enabling the wheel to roll in any direction.
This makes it possible to easily move the trolley in any direction without changing its orientation.
So eight swivel caster (according to trolley length) were selected from market and they were fitted on mounting brackets, which were welded (MIG) on frame at convenient place.

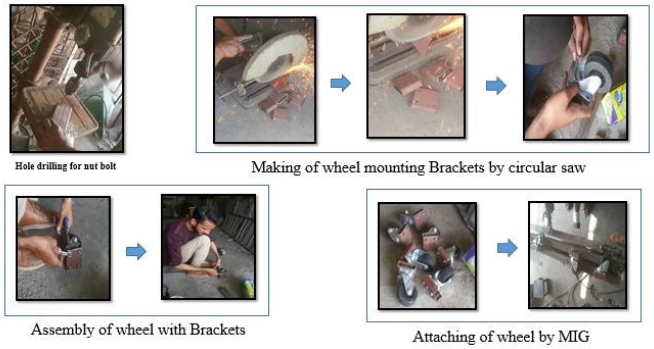

Fig-8 Caster fitting

3.8 Adhesion of rubber friction pads

Rubber friction pads (total four) were adhered to the bottom and top of ladder to provide it friction against slipping. Adelaide adhesive was used to achieve this purpose.

Fig-9 Adhesion of rubber friction

4. Model Features

All in all model provide various features such as it can be used as ladder, slope, trolley as well as it is portable and foldable.

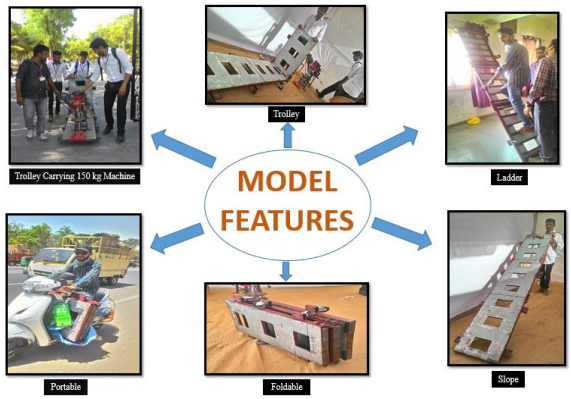

Fig-10 Model features

5. CONCLUSIONS

In a nutshell, the final product serves multiple purposes despite of being very simple from design point of view. The fabrication was done in local markets. Thus, it can be said that its manufacturing will be relatively easy for the local manufacturers (INDIAN) who normally has a very basic machineries. Also, the final product is compact and portable. The parts used in the design including MS channels, GI plates, hinges, door latch type locks, rubber friction pads etc. are easily available in the market. In addition, the final product can be used as a ladder, trolley and an inclined surface for material for handling along with the load carrying capacity of a 150kg. Changes can also be made in the design depending upon the requirements.

REFERENCES

1. R. K. Rajput. A Text Book of Manufacturing Technology (Manufacturing Processes). Chapter-Welding and allied processes. Firewall Media, 2007 - Manufacturing processes - 899 pages
2. R.S. Khurmi and J.K. Gupta. A Text Book of Workshop Technology: Manufacturing Processes. S. Chand Limited, 01-Jan-2008 - Machine-shop practice - 551 pages
3. Ladder Safety including Ladder Types (Type I, Type II, Type III)
4. OSHA Ladder guidelines including OSHA approved rung spacing requirements, etc.
5. Cutler, Deborah W. and Thomas J. Cutler (2005). Dictionary of Naval Terms. Naval Institute Press, Annapolis, Maryland. ISBN 978-1-59114-150-1.
6. "British and European Ladder Certification Standards". Clow Group Ltd.
7. "Louver from "Encyclopedia Britannica"". Encyclopedia Britannica. Retrieved 2 March2014.
8. Engineering fundamentals page on low-carbon steel.
9. Warner book for ladder.
10. "Physical Metallurgy, Principles and Practices" by V Raghavan.
11. Indiana Gratings Private Limited. (Fabricated steel structure Manufacturer).
12. Dr. Manish A. Rachchh, MPharm, Ph.D., Associate Professor, center of pharmaceutical sciences - GTU.
13. Mr. Anil Pandey, Head (IPR) CII, Ahmedabad.