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Design & Fabrication of Foldable Automatic Stairs

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Abstract - *In numerous mechanical Industries hardware is on the top or spot the floor savvy. For overabundance reason steps are utilized. Be that as it may, for steps more space is required. For space sparing, there is ill-advised structure of steps and it is extremely perilous for laborers to work there. Because of such steps odds of mishaps or increments. To conquer space issue this venture manages minimal plan of steps. Because of reduced plan space usage is less and because of legitimate structure, there are less odds of mishaps. The steps work on scissor system by pneumatic which is more secure than water powered activity.*

Key Words: **foldable staircase**, **ladder**, **scissor mechanism**, **four bar links**, **Pneumatic Cylinder**, **Mild Steel**

1. INTRODUCTION

What is Foldable Staircase system: The requirement for versatile and reusable structures that are portrayed by quick and simple erection strategies has existed for a significant stretch. the deployable structures were tested as right on time as the nineteenth century by Sarrus, Bricard, and in the mid twentieth century by Bennettet al .Deployable structures were broadly overviewed and used in space structures with the expanding needs of complex space missions in 1970s. Deployable structures comprise of units, which are made out of sets of bars associated at joint that permits a reduced and sent setup. These structures can be put away in a reduced setup and are intended to venture into stable structures equipped for conveying loads after sending. One of the most significant foldable/deployable structures utilized in building is the scissor-connect structure. a scissor-like component (SLE) has a couple of equivalent length bars associated with one another at a middle of the road point with a revolute joint**.**

1.1 Objective AIM

To design and fabricate the prototype of foldable staircase mechanism. To create extra new feature, creative and innovative design. Also due to foldable staircase we get more storage space which is very useful in industries. Foldable staircase is requires less space, material & time to build. Sample Preparation and Testing Load bearing capacity is 150 kg**.**

1.2 Components

The different components are as follows:

- Vertical Link
- Horizontal Link
- Slider
- Connecting Rod
- Crank
- Air Compressor

2. Material Specifications

We Are Using the Mild steel.
Because, corrosion resistance , excellent drawing, forming, and spinning properties , Density of MS is 7.86 g/cm3 , Melting Point of MS is 1350°C to 1530°C , non-magnetic

Table -1: Mild Steel Composition

Element & Content (%)			
Iron,Fe	72	Sulphur	0.04
Phosphorus	0.04	Carbon, c	0.05-0.25
Manganese, MN	0.7-0.9		
Nickel,Ni	3.50-5.50		
Silicon, Si	0.4		

3. Mechanism of Foldable Stair

The foldable step component comprises of connections masterminded in vertical and even way that make up the step like course of action. These connections are associated with one another utilizing revolute joints. The wrench in the wrench and slider instrument, which pulls the whole arrangement of connections up or down makes the step like course of action. This wrench likewise acts like an info interface for the four-bar system. This collapsing and unfurling of the step take after the scissor like structure. The wrench is associated with the interfacing bar through a revolute joint, which moves because of the incitation of the slider. The slider moves straightly because of the interpreter movement displayed by the direct actuator. The development of the instrument is as appeared in Fig Two arrangements of this planar system are set corresponding to one another at a counterbalance separation. The even connections in the two sets are associated together by utilizing a bar over which the foot of the client is put.

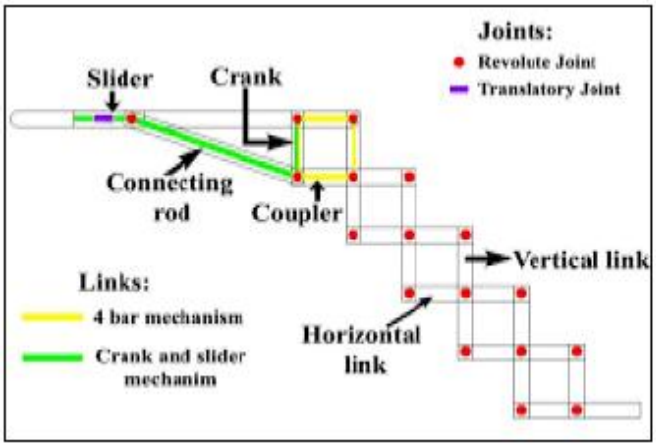


Fig -1: Mechanism of Foldable Stair

3.1 Basic Construction

1) Vertical connections the vertical connections are associated with the even connections at a few focuses. It is utilized to overlay or discharge the level connections when it is incited by the wrench. They choose the tallness of each progression in the step.

2) Horizontal connections they are associated with the vertical connections at a few focuses through a revolute joint. It is utilized to give a stage where the foot of the client can be kept. It chooses the length of each progression in the step.

3) Slider The slider is utilized to incite the system because of its direct movement. It moves because of its connection to the pole of the twofold acting chamber toward one side. The opposite end is joined to the interfacing pole through a revolute joint.

4) Connecting pole it is associated with the slider through a revolute joint toward one side and the opposite end is associated with the wrench and coupler of the four-bar instrument through a revolute joint. The interfacing bar is used to move the straight movement of the slider to the rotating movement of the wrench. By changing its length, the direct power required for incitation and the straight separation to be moved by the slider shifts which is concentrated in detail in this paper.

5) Crank The wrench is utilized to move the movement from the interfacing bar to the coupler. At the point when it turns, the movement is moved to the level connection (coupler of the four-bar system) which further reason

6) Air Compressor: An air blower is a gadget that changes over force (utilizing an electric engine, diesel or fuel motor, and so on.) into potential vitality put away in pressurized air (i.e., compacted air). By one of a few strategies, an air blower powers increasingly more air into a capacity tank, expanding the weight.

3.2 Methodology of Working

The slider moves directly (- X hub) and pulls the interfacing pole in reverse. The associating bar thus turns the wrench and simultaneously pulls the coupler of the four bar system forward. The coupler thusly pulls the vertical connections which thus pulls the even connections upward. This makes the step to be in the collapsed position. At the point when the step should be unfurled, the slider moves along the +X hub which pushes the interfacing pole forward. This pivots the wrench which thus pushes the coupler forward. This makes the vertical connections move in this manner unfurling the step.

4. CALCULATION

1. Assume,
UDL act on stair,
Max. Load bearing capacity=150kg

Take one step,
1m=100cm
? = 45.72cm
= 45.72/100 = 0.4572m ...1

150kg=1.471KN

1Kg=0.009807KN
150Kg=?
=1.47105KN ...2

From ...1 & ...2 make UDL act on one step

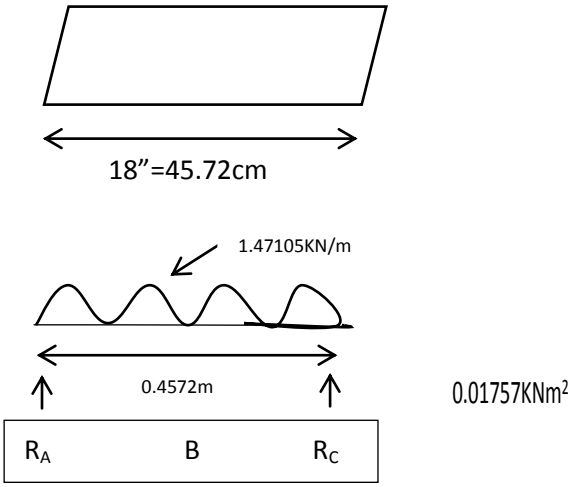


Fig (A)

Convert UDL to point load
1.47105KN/m * 0.4572m
=0.67256KN

From fig. A convert UDL to point load in fig. B
RA 0.67256KN RC

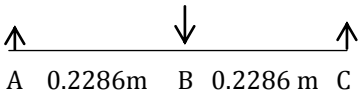


Fig (B)

Take M@A,
Rc * 0.4572 =0.67256 * 0.2286
Therefore, Rc=0.33628KN
Take M@C,
RA*0.4572=0.67256*0.2286
Therefore, RA=0.33628KN

Vertical equilibrium,

RA+RC=0.33628+0.33628
=0.67256KN

4.1 Shear Force Diagram

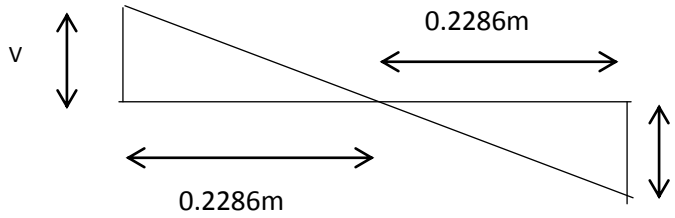


Fig (C)

V=wl/2
=0.67256*0.4572/2
=0.15374Nm

4.2 Bending Moment Diagram

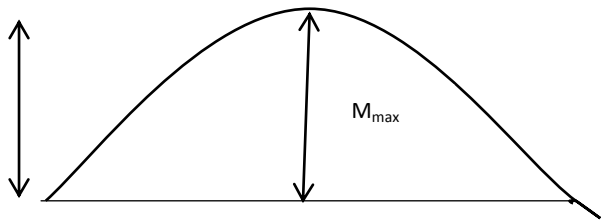


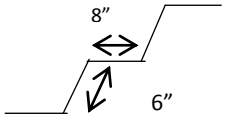
Fig (D)

Mmax=wl2/8
= 0.67256*(0.4572)2/8
= 0.01757KNm^2

This is load calculation for one step.

4.3 stair angle

side view of stair FBD



Length of vertical link = 6inch
Width of one step = 8inch
From stair angle formula
tan θ=vertical link/width of step
= 6”/8”
θ = tan^{−1}(6”/8”)
= 36.86°

5. Images

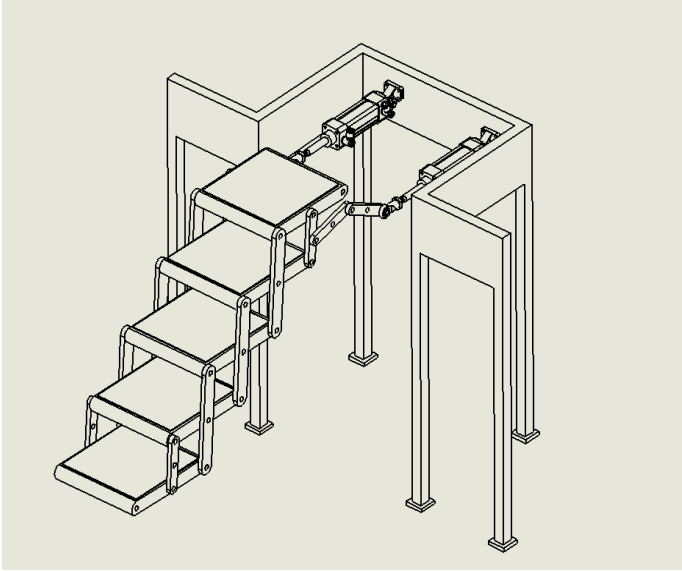


Fig -2: Wireframe design

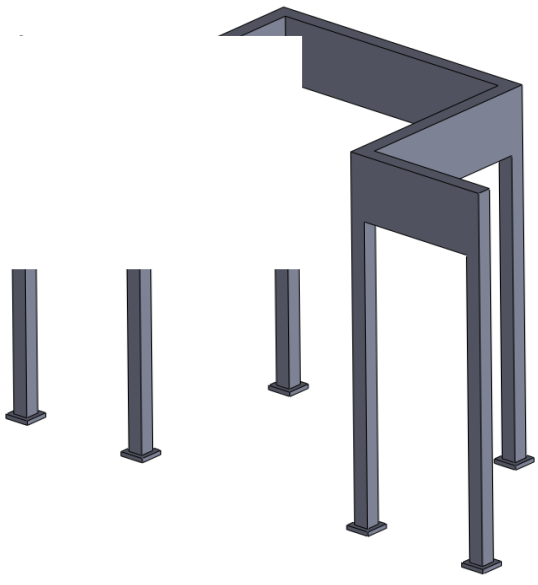


Fig -3: Frame

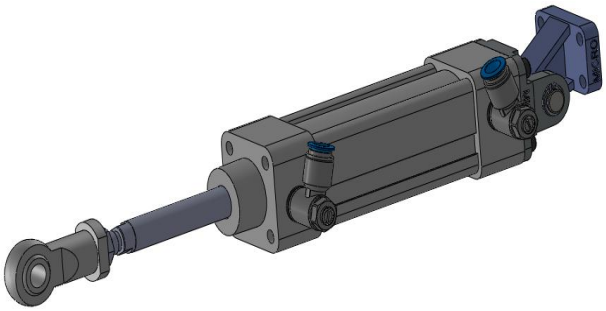


Fig -4: Pneumatic Cylinder

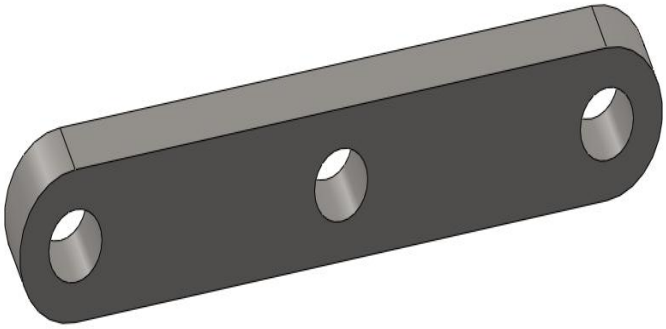


Fig -5: Short Link

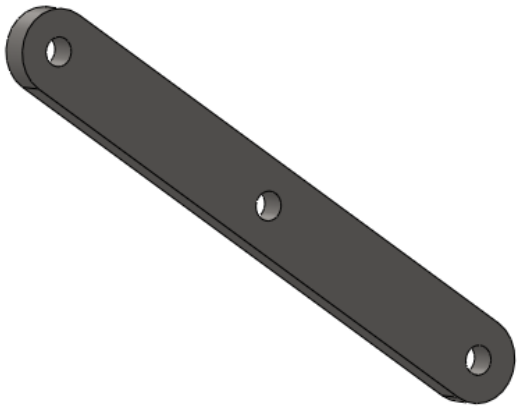


Fig -6: Long Link

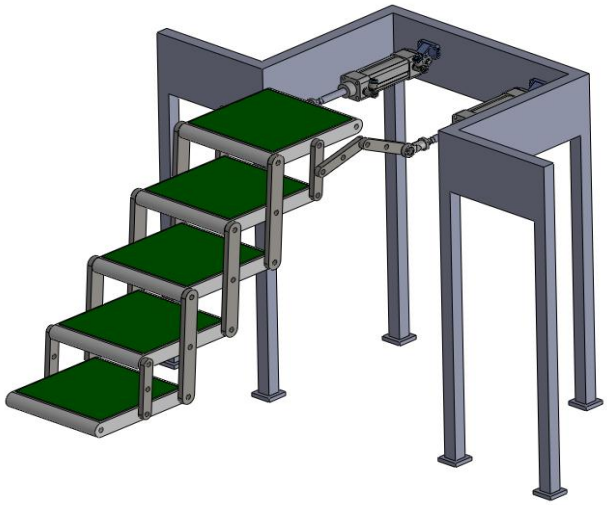


Fig -6: Final Assembly

6. Conclusion

Along these lines, in this undertaking work, a foldable step instrument activated directly is structured and talked about in detail. There are two such arrangements of component put at a counterbalance good ways from one another. The level connections in the two sets are associated together utilizing a bar over which the foot of the client can be kept. The length of the interfacing bar in the wrench and slider component puts a significant job in choosing the power required for activation and stroke length required. Along these lines, ten unique lengths of interfacing pole are considered and the power required and stroke lengths required for activation were examined. The instrument was displayed and reproduced to check it's working. To make extra new element, inventive and imaginative plan. Likewise because of foldable flight of stairs we get more extra room which is helpful in businesses and House. Foldable flight of stairs is requires less space, material and time to construct. This Staircase is adaptable to utilize.

REFERENCES

[1] D. Kornack and P. Rakic, "Cell Proliferation without Neurogenesis in Adult Primate Neocortex," Science, vol. 294, Dec. 2001, pp. 2127-2130, doi:10.1126/science.1065467.

[2] M. Young, the Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[3] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[4] K. Elissa, "Title of paper if known," unpublished.

[5] http://asm.matweb.com/search/SpecificMaterial.asp?bassnum=mq304a

[6] https://www.google.com/search?q=mild+steel+properties&tbm=isch&source=iu&ictx=1&fir=trhqOKRC-UWAhM%253A%252CTZ3By5otcXRmDM%252C_&vet=1&usg=AI4_-kQl_pB6tVkTjcldzEum8lcVhwB1Kw&sa=X&ved=2ahUKEwiw4bGin9_mAhVPT30KHf70BmwQ9QEwD3oECAQQLA#imgrc=trhqOKRC-UWAhM:

[7] https://sci-hub.tw/

[8] Engineering Properties of Steels, Philip D. Harvey, editor, American Society for Metals, Metals Park, OH, (1982)

[9] Handbook of Stainless Steels, Donald Peckner and I. M. Bernstein, McGraw-Hill Book Company, New York, NY, (1977)

[10] Metals Handbook, Howard E. Boyer and Timothy L. Gall, Eds., American Society for Metals, Materials Park, OH, 1985.

[11] Metals Handbook, 10th ed., vol. 1, ASM International Handbook Committee., ASM International, Materials Park, OH, (1990)

[12] https://www.azom.com/article.aspx?ArticleID=2867

[13] https://www.researchgate.net/publication/275540840_Modelling_Simulation_and_Control_of_a_Foldable_Stair_Mechanism_with_a_Linear_Actuation_Technique

[14] http://www.metallurgist.com/folding-ladder-failure.html

[15] https://www.wenzelmetalspinning.com/steel-vs-aluminum.html

[16] https://study.com/academy/lesson/staircases-types-design-construction.html

[17] https://www.sportsrec.com/disadvantages-elevators-6828149.html

[18] https://m-alibaba-com.cdn.ampproject.org/v/s/m.alibaba.com/amp/showroom/folding-stairs-design.html?amp_js_v=a2&amp_gsa=1&usqp=mq331AQCKAE%3D#referrer=https%3A%2F%2Fwww.google.com&aoh=15765596695103&amp_tf=From%20%251%24s&ampshare=https%3A%2F%2Fwww.alibaba.com%2Fshowroom%2Ffolding-stairs-design.html

[19] https://www.instructables.com/id/How-to-Make-a-Folding-ladder/

[20] chepizza.info/fold-up-stairs/photos-gallery-of-advantages-collapsible-stairs-fold-up-out-loft/

[21] www.wlt.nl/folding-stairs/

[22] https://www.thebalancesmb.com/step-by-step-on-how-to-build-a-staircase-845013

[23] https://www-pinterest-com.cdn.ampproject.org/v/s/www.pinterest.com/amp/pin/534661786981702090/?amp_js_v=a2&amp_gsa=1&usqp=mq331AQCKAE%3D#referrer=https%3A%2F%2Fwww.google.com&aoh=15766517164591&amp_tf=From%20%251%24s&ampshare=https%3A%2F%2Fwww.pinterest.com%2Fpin%2F534661786981702090%2F

[24] https://good-design.org/projects/bcompact-hybrid-stairs/

[25] https://civil4m.com/threads/types-of-staircase-designs-with-advantages-and-disadvantages.7198/

[26] biblus.accasoftware.com/en/how-to-design-stairs-criteria-and-examples-to-download/

[27] https://www.houzz.in/photos/folding-staircase-phbr0lbl-bl~l_157890

[28] https://m.youtube.com/watch?v=zBupI7Kc3E4

[29] https://m.youtube.com/watch?v=uhWTuiTKmxE

[30] https://www.core77.com/posts/15191/Solutions-to-stairs-part-2-Folding-scissor-steps

[31] https://video.archiexpo.com/video_ae/videos/accordion-protection-ladder-retractable-aluminum-95842.mp4

[32] http://www.scari.it/portfolio-items/electric-scissor-loft-ladder/

[33] https://www.industrybuying.com/spring-monroe-AU.AU.AU.SP.1630773/?utm_source=Google&utm_medium=PLA&utm_campaign=PLA_Automotive_Maintenance_and_Accessories&gclid=EAIaIQobChMI4KPepM7g5gIVixePCh2wgwx9EAYYAyABEgLMVvD_BwE

[34] https://www.industrybuying.com/single-phase-motor-mxvolt-MO.A..SI.433243/?utm_source=Google&utm_medium=PLA&utm_campaign=PLA_Motors_and_Power_Transmission&gclid=EAIaIQobChMIp7fh3s_g5gIVyI2PCh3LSwtxEAYYASABEgJsZ_D_BwE

[35] https://www.amazon.in/Head-Bolts-Nuts-Pack-sizes/dp/B014UR248O/ref=asc_df_B014UR248O/?tag=googleshopdes-21&linkCode=df0&hvadid=397005962098&hvpos=1o2&hvnetw=g&hvrand=17324239281107703965&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=1007753&hvtargid=pla-404032701506&psc=1&ext_vrnc=hi

[36] https://www.researchgate.net/publication/265756146_Mechanism_Synthesis_of_a_Foldable_Stair

[37] https://www.sciencedirect.com/science/article/pii/S0020768304005050?via%3Dihub

[38] https://www.sciencedirect.com/science/article/abs/pii/S0094114X11000255?via%3Dihub

[39] https://journals.sagepub.com/doi/10.1260/026635101760832172

[40] https://www.researchgate.net/publication/275540840_Modelling_Simulation_and_Control_of_a_Foldable_Stair_Mechanism_with_a_Linear_Actuation_Technique/link/5552a7ea08aeaaff3beffc78/download