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Design Fabrication and Performance of Push Plank Equipment for Fitness

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***Abstract*— The project aims at design and fabrication of Push plank equipment for fitness. The word Push plank is used here to refer that this equipment provides the benefit of both push up and plank exercise. Both these workouts combined helps in acquiring a full body workout. This type of equipment is preferred for home fitness because of their characteristics like size, portability, etc., The equipment has many design considerations pertaining to human ergonomics which makes the equipment human friendly, based on anthropometry. Sarrus Linkage mechanism incorporated with lever mechanism is effectively used in the designed equipment.**

Keywords—Ergonomics; Anthropometry; Sarrus Linkage; Push up; Plank

I. INTRODUCTION

Push-ups and planks have been identified to provide a full body workout and are effective compared to cardio vascular workouts. Thus, a home fitness equipment for performing push up and planks was designed. The home fitness equipment can be referred as "Push-Plank Home fitness equipment"

Design for a home fitness equipment involves the understanding of human ergonomics and the proper movement for muscle gain and workout effectiveness. In other words, the equipment must be made for a human to use it conveniently. It is designed based on sarrus linkage mechanism [1]. In typical sarrus linkage, the mechanism is used for converting a limited circular motion to a linear motion [2].

II. HUMAN ERGONOMICS

Ergonomics refers to the study of convenience and usability of an equipment. Human Ergonomics as the name suggests, refers to the understanding of human needs and conveniences while designing an equipment or device with human as user [3].

III. NEED FOR PLANK FITNESS EQUIPMENT

The project for design and fabrication of "Push-plank" Home fitness equipment for push up and plank was carried out in order to learn the design parameters and effective application of design in the actual product through various fabrication procedures and selecting the effective one.

Fitness is a daily activity to be carried out and this equipment can be used to gain a full body workout at minimal effort. The project also aims at producing a low-cost home fitness equipment without much complexity of usage.

IV. METHODOLOGY

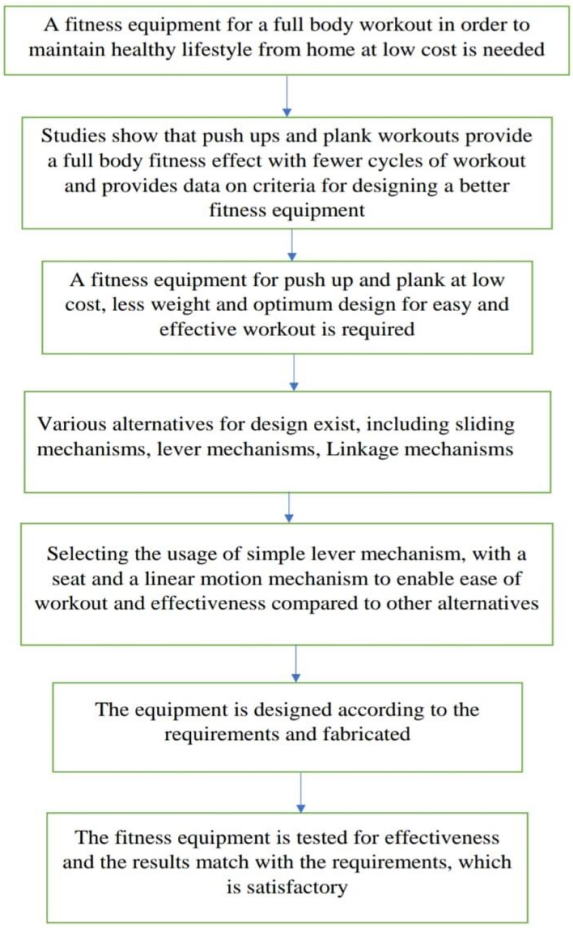

Fig: 1. The methodology for the project was based on Shigley's Design process is shown in the figure.

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IV. DESIGN OF BASE FRAME

Material used: Carbon steel C30 (Yield strength S_{yt}= 310 N/mm^2)
Considering the application with mild to medium shocks and small impacts,
Factor of Safety, fos = 2

Design stress = $\frac{S_{yt}}{fos}$ N/mm^2
= $\frac{310}{2}$ N/mm^2
= 155 N/mm^2

Actual stress = $\frac{P}{A}$ N/mm^2

P = 2000 N (assuming human weight to be 200 kg for safer consideration)
A = 2400 mm^2 (for a plate 400 mm wide, 6mm thick with 13mm hole at center)
Therefore, Actual stress = 1 N/mm^2
The design is safe and can withstand more impact loads

V. DESIGN OF LINKS AND SUPPORT

Material used: Carbon steel C30 (S_{yt} = 310 N/mm^2)
Here Crushing stress and shear stress takes place
fos = 2

Design stress = $\frac{P}{2\times fos}$ N/mm^2
= $\frac{310}{2\times 2}$ N/mm^2
= 77.5 N/mm^2

Actual Stress = $\frac{2\times P}{A}$ N/mm^2 = $\frac{2\times 2000}{2400}$ N/mm^2
= 2 N/mm^2

VI. FOR EFFECTIVE LIFT OF THE HUMAN BODY

Distance between the body weight to lever end = 0.4 m
Lift required in the equipment
= 0.1 m – 0.17 m
Body weight in kg

Effort required to lift the body can be denoted as "F"
Here, for lift to occur,
F x 0.4 = 0.1 x Body weight
Since lever is used in both sides, the actual effort from each hand is F/2
Therefore,
F = 0.25 x Body weight
Actual effort from each hand will be,
F/2 = 0.125 x Body weight
Assuming human weight to be between 60 kg to 100 kg
Actual effort = 7.5 kg to 12.5 kg
For human,
Effort from each hand will be 12 kg to 35 kg which is suitable to operate the equipment

VII. SELECTION OF FASTENER

Shear stress on the bolt s = $\frac{P}{A}$ N/mm^2

Here P= 2000N and A=84.3 mm^2 for M12 coarse series PSG Design data
Therefore, s = $\frac{2000}{84.3}$ N/mm^2
= 23.72 N/mm^2 < 77.5 N/mm^2
which is safe stress
Crushing stress for minimum thickness (since it will be maximum stress) is lesser than the above calculated stress. Therefore, the M12 fasteners can be selected for safe design.

VIII. LIFT OF THE EQUIPMENT

The required lift of the equipment can be achieved by maintaining the angle pushed by the lever.
Angle moved by the lever for lift of 0.1m can be given as
a = $\sin^{-1}(\frac{opp}{hyp})$
where, opp = 0.1 m
hyp = length of the bar after the bush (0.34 m)
a = 15^0 app.
In actual equipment the lift is given on both sides from the mean horizontal line to the bush axis.
Therefore, for angle of lift of 30^0 (must be near to 2a value)
sin 30^0 x hyp = lift
lift = 0.17 m app.
The lift of the follower ranges between 0.1 m to 0.17 m which varies based on user's ability to apply effort

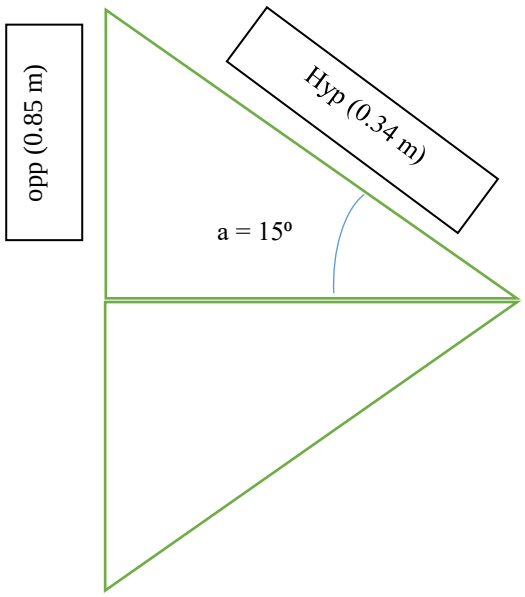

Fig 2. Representation for the lift of equipment.

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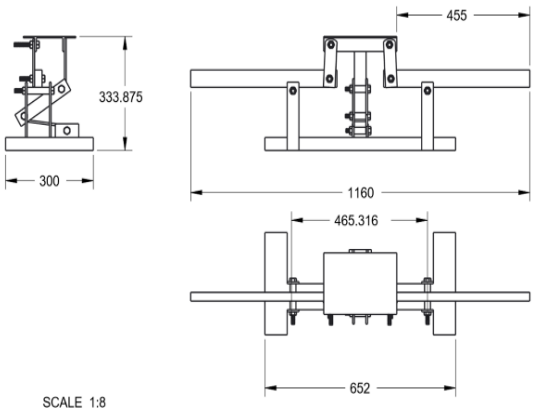

Fig 3. Orthographic projection of the push plank fitness equipment assembly with dimensions in millimeters.

IX. PERFORMANCE OF THE EQUIPMENT

The comparison between the push – plank equipment and other fitness equipment is made based on the study and analysis of different fitness equipment [4][5][6].

After fabricating, the equipment is tested for convenience and performance by several people ranging from age 10 to 40. From the feedback, the following information were obtained.

TABLE I. COMPARISON OF EQUIPMENT PARAMETERS OWING TO PERFORMANCE

Parameter	Other equipment (average considerations)	Push-Plank equipment
1. Size	150cm x 70cm	115 cm x 45 cm
2. Operation style	Sitting, lying on back	Lying on chest, plank
3. Human effort	Pushing, pulling	Pushing
4. Equipment complexity	More complex	Less complex
5. Use of motors	Yes	No
6. Use of springs, flywheels	Yes	No
7. Cost	High	Low
8. Time for adapting to the equipment	2 – 3 sessions	4 – 5 sessions
9. Regions of the body worked	Biceps, chest, shoulder. Only a single region or two of above can be done.	Biceps, Triceps, Shoulders, Calf, Abdomen, chest regions
10. Effort for workout	Moderate	Low
11. Long term benefits	Low	High
12. Weight of equipment	Greater than 15 kg	11 – 12 kg
13. Portability	Can be moved using wheels	Can be lifted
14. Implementation of electronics	Possible	Possible
15. Product life	Medium (2 to 3 years)	High (4 to 5 years)
16. Human comfort	Too high	High

Fig 4. Fabricated Prototype of the push plank equipment.

The push – plank equipment has the following characteristics

- The equipment is lighter in weight compared to similar fitness equipment.
- The absence of electrical actuation helps the functioning of the equipment without any electricity.
- The equipment does not require additional weights to perform the workout operations.
- The resting allotment is a characteristic of the design and is found in this equipment alone.
- The links are rigid, lighter compared to other similar variants.
- The operation of the equipment helps in attaining a full body workout.

The equipment has numerous advantages as mentioned earlier. Some limitations were found in the equipment and they were as follows:

- The equipment is not foldable i.e. the fitness equipment cannot be placed in a cupboard or under the bed. This is due to the shape of the equipment designed.
- The equipment cannot be used for heavy muscle gain and workouts.
- The user feels a little unused when operated for the first few sessions.

Though the above limitations exist for the equipment, the following advantages tend to minimize the impact of the limitations while preferring the equipment.

- The equipment can be dismantled easily using a spanner, as fasteners are used to assemble the members of the equipment. The equipment can thus be transported to longer distances.
- The time for dismantling and reassembling take about 5 – 10 minutes which is optimum.
- The equipment helps in maintaining a rigid balanced healthy body, which is effective in home.
- The position of the working out in the equipment is a new idea, which makes them feel unused. This generally get easy on the longer run [7].

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The handlebar has no additional handles because the provided bar was convenient to produce the required health benefits. The seating or the rest allotment is produced with a soft material to reduce the strain produced in the chest after prolonged usage due to the hard metal interaction. The effort to be provided is much lower in the equipment to make the lift, thus ensuring ease in making the workout even for the beginners. The center of gravity of the equipment is balanced and the weight of equipment is around 10 kg which can be lifted easily with handles.

The metal is coated with acrylic lacquer to provide corrosion resistance and to ensure better appeal of the equipment. The equipment can also be dismantled by removing the fasteners for any changes or to transport to distant places than within the house. Since no bearings are present in the equipment, grease is applied at the joints to reduce wear which is minimal and does not affect the life of the equipment.

X. FUTURE SCOPES

The push plank fitness equipment can be provided with different angular handles for different push up and plank positions which helps in improving the muscles in the different regions of the body. This can be achieved by fitting handles viz. welding or fasteners.

The number of push-ups made in the equipment can be counted electronically and displayed using an LCD display. This helps the user to improve his workout level for a better physical health. The counting can be done using sensors or physical buttons in the equipment and connecting it to LCD display through a processing unit. The unit increases the cost of the equipment by a Rs.1500 but provides better accessibility.

The home fitness equipment can be digitalized using IoT. This includes calculation of BMI, improvements in the body condition as a result of usage of the equipment, Calories burned, Number of push-ups made or time period of plank. All these data can be stored and viewed using a smart phone or computer through the internet. Cloud based devices can be used to store and retrieve this data. The data can be sent to the cloud using a processing unit and Wi-Fi module with network accessibility. This technology is becoming a trend and implementation increases the cost by double.

The push plank equipment can be provided with further provisions such that other types of workouts can also be performed using the equipment. For example, the device can be provided with holders to perform crunches and stretches effectively along with pushups and planks.

XI. CONCLUSION

The purpose of the project was to design a home fitness equipment to perform a full body workout. The various full body workouts were studied, and pushups and planks were selected to be the workout to be performed using the equipment. The equipment can help the user to perform the workouts push and plank together effectively in order to gain a healthy body. The project also aimed on creating this equipment at a price lower than the other home fitness equipment variants which costs more than 4000 rupees. The aim was achieved by producing the equipment within a cost of 3000 rupees, which can be reduced further with optimizations in fabrication process. The equipment made was able to function effectively and is suitable for people above the age of 10 and is appropriate for use by all gender people.

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REFERENCES

[1] Waldron, Kenneth et al., Kinematics, Dynamics, and Design of Machinery. West Sussex, UK: John Wiley & Sons. p. 367, 2016. ISBN 9781118933282.
[2] Ding, Xilun; Kong, Xianwen; Dai, Jian., Advances in Reconfigurable Mechanisms and Robots II. Cham, Switzerland: Springer. p. 107, 2015. ISBN 9783319233260.
[3] Pandve HT, "Historical Milestones of Ergonomics: From Ancient Human to Modern Human". *J Ergonomics 7*., e169, 2017. doi: 10.4172/2165-7556.1000e169.
[4] Device and method for performing push-up exercises, by Frank Bergman et al., (2006, June 13), Patent US 7,060,014 B2.
[5] Push up/pullup exercise apparatus and methods for use, by William Richard Dubrul et al., (2008, Jan 15), Patent US 7,318,793 B2.
[6] Perfect push-up apparatus, by Salvatore V. Denaro (2000, Oct 10), Patent US0061296.51A
[7] M. K. Gouvali et al, "Dynamic and Electromyographical Analysis in Variants of Push-Up Exercise", *NSCA J. Strength and Conditioning Research.*, vol. 19, no.1, pp. 146-151, 2006.