

Vacuum Assisted Climbing Device

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Abstract

Vacuum Assisted Climbing Device is a new way to climb vertical surfaces like wall, buildings easily and faster than the conventional methods like ladders and ropes etc. This device works on the vacuum to climb the vertical surfaces as its name indicates and this vacuum is utilized by two suction pads which are available in the hands of the climber and the suction pads are connected with the suction motor (vacuum pump) with the hoses.

Index terms— suction pads, vacuum pressure (suction force), suction motor (vacuum motor).

1 Introduction

Vacuum Assisted Climbing Device is a wall climbing machine which uses vacuum as a source to climb the vertical surface through the suction which utilizes the vacuum, created by the vacuum pump (suction motor). This is a wall climbing machine which uses its vacuum pumps (suction motor) to produce a grip against the wall surfaces. It can climb up to any height on any surface including glass, brick or without a rope. But the most important element was to come up with technology that can grip to any vertical surface. So we developed this machine which is made from two pads and suction motor which are connected to each other with the hoses for air suction and wire for the electrical supply. The pads are made up of MDF (medium density fiber) board and the latex rubber.

The suction pads are designed after the pressure and force calculation which is done by using the pressure at the end of the suction line and the area of the suction pad (inner and outer area of the pads have to be measured)

As we know in the many industries suction pads are used for material handling even in robotics the suction cups are used to hold the object and provide a complete grip to the user.

Thus we design the suction pad which are connected to the suction motor which sucks the air from the pad's inner area and create the vacuum which enables the pad to stick on the wall without damaging it and provide a proper grip to the user.

The effectiveness of the pads are totally depend on the vacuum pump and the area of the pad and the material of the rubber which works as blocking agent or make the pad leakage free.

The rubber which we use to make the pad is latex rubber which has good water and temperature resistant property and is stronger than the natural rubber which also increases the life and the efficiency of the pad.

We have tried to make the complete device as light as it possible which allow the user to make irritation less effort to climb the vertical surfaces, and we use the synthetic plastic strips to make the leg linkage which is used to tow the heavy loads like vehicle and heavy containers as we need to carry all the load on a single pad with this linkage on hold position or while stepping upward.

We can climb the wall by using the ON/OFF switch which is provided near to the handle of the pad by active and inactive the pad with this switch along with the movement of the corresponding leg linkage.

2 II.

3 Methodology

After some research, a human climbing mechanism known as PVAC (Personnel Vacuum Assisted Climber) engineered by Utah University UG students was found. As papers about their work were not available, a from-the-scratch approach was adopted for designing.

10 CONCLUSION

45 To check the feasibility of the we perform an experiment with the suction pad which was made up of plywood
46 and the home vacuum cleaner pump, which was enable to stick on the wall. The initial prototype system could
47 bear a load of up to a 100kg, which was encouraging.

48 The dimension of the suction pads were obtained from design analysis and for this reverse engineering approach
49 was adopted in designing the equipment. It is the heart of the system which runs the complete system by creating
50 the vacuum in the suction pad cavity, which allows the pads to stick on the surface of the wall with the help
51 rubber.

52 4 b) Electric source and wires

53 An A.C power supply has to provide the system so that vacuum pump (suction motor) can run and whole system
54 can start their function.

55 5 Hose pipelines

56 It creates the connection between vacuum pump and the suction pad which help and provide a path to the
57 vacuum pump to suck the air from the pad cavity.

58 6 Suction pads

59 Suction pads are the second most important part of the system by which a climber can climb the wall and whole
60 weight would be bear by the suction pad at halt position, thus it must be strong enough to bear a sustainable
61 load of the climber and some objects that would be carried by the climber. There is a safe altitude up to which
62 the equipment can safely operate. Also it depends upon the load acting on equipment. Since he machine has an
63 ultimate normal load capacity of 600 kg, margin of 200 kg is given. SO the ultimate is 400 kg.

64 7 Safe load

65 Assuming factor of safety= 3 Note:-As per standardization we need to take higher value of the fos for lifting
66 device thus we take it 3.

67 Safe load = $400/3 = 133.33 \sim 120 \text{ kg} = 120 \text{ Kg V.}$

68 8 Fabrication

69 a) The properties of the rubber used for pads 1. Latex rubber is generally made up of around (55 to 65)% water
70 and (30 to 40)% of rubber material. 2. It also contain sugar, resin, protein and ash, it undergoes exposure to
71 sulfur, carbon black and oil which make the latex stronger. 3. The most ideal working temperature range is
72 between -55 degrees Celsius and 82 degree Celsius. 4. It is water resistant and stronger than natural rubber.

73 9 b) Procedure to make pads and the complete device

74 ? Firstly cut the MDF (Mean Density Fiber) board in the desired dimensions. ? Then cut the latex rubber in
75 the desired dimensions.

76 ? Then drilled a hole of 0.0508m in the board to fix the hoses. ? Then remove some material from the MDF
77 board where the rubber needs to be fixed, with the help of emery paper. ? Then paste the latex rubber with
78 the help of araldite and clamp them for overnight and let it dry. ? Once the rubber is pasted on the board then
79 make the wire and hose connection with the vacuum motor (suction motor). ? Add an ON/OFF switch on the
80 each pad.

81 ? In this device two vacuum pump and two pads are used.

82 VI.

83 10 Conclusion

84 Firstly we have tested the pad with suction motor having the capacity of 600W but there was some leakage in
85 the pad thus test was failed then we had glued the rubber on the plywood pad again to remove the leakage.

86 Second time we used the suction motor having capacity of 1500W and we used MDF (Medium Density Fiber)
87 board which is light in weight and has good strength to carry load and design the pads as per the calculation
88 after the final test we conclude this vacuum assisted climber is the best option for the wall climbing. This vacuum
89 assist wall climber gives chance to carry heavy work to the climb and its bonding would withstand 100kg load.

90 We make the entire system with less weighted and aesthetics and ergonomic consideration this assist wall
91 climber reduce the human efforts. The equipment provides high load carrying capacity. The designing and
92 testing stages were successful and performance of the equipment was found excellent.

93 The future scope of the equipment includes addition of the individual sensors in each suction pad and addition
94 of the compact batteries.

95 Each time suction pad and adhere to surface, the pressure inside the suction pad varies. It is necessary to
96 ensure that the suction created is sufficient for holding the weight.

97 Another scope is addition of compact high power batteries. This will increase the flexibility of the operation.
98 Also addition of battery level sensor is a need to indicate battery level.

99 In the future the mechanism can be automated with the help of sensors and the artificial intelligence which may increase its durability and the life of the machine. ¹



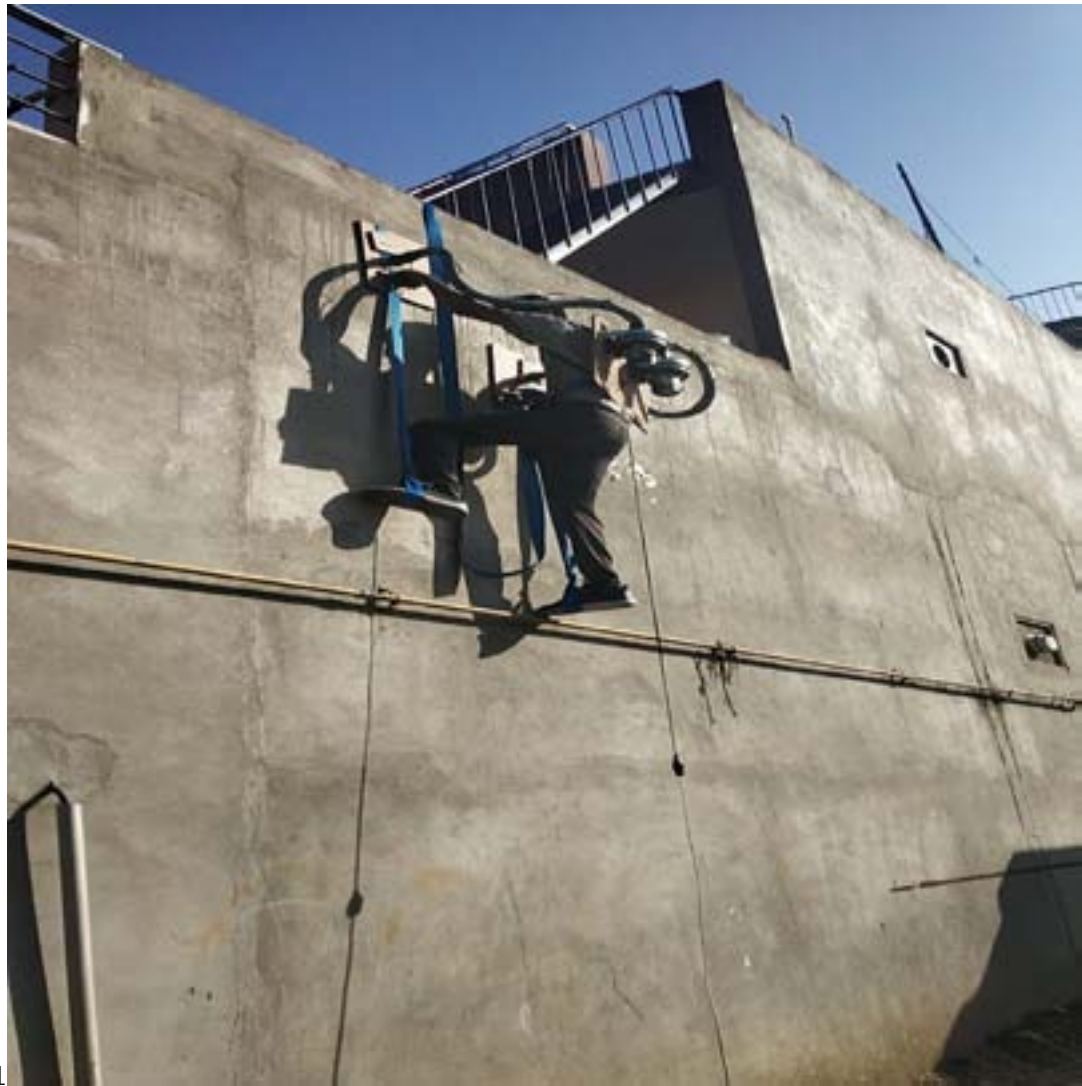
Figure 1: Fig. 2 . 1 :

100



22

Figure 2: Fig. 2 . 2 :



141

Figure 3: Fig . 3. 1 :Fig. 4 . 1 :

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