Air Suspended Vehicle for Internal Transportation Purpose

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Abstract— The air cushion vehicle or hovercraft, as it is popularly known is the newest vehicle in today's transport scene. As well as being new, this vehicle is different from other more conventional, terrestrial vehicle in that it requires no surface contact for traction and it is able to move freely over a variety of surface while supported continuously on a self-generated cushion of air. In this study we are using plywood of length 1m and width 0.5m, skirts as same dimensions of plywood, prime mover to develop a model of air suspended vehicle to carry the load of 25kg.

Key words: Air Suspended, Internal Transportation, Air Cushion

I. INTRODUCTION

Air suspended vehicle is a transportation vehicle that rides slightly above the earth's surface. The air is continuously forced under the vehicle by a fan, generating the cushion that greatly reduces friction between the moving vehicle and surface. The air is delivered through ducts and injected at the periphery of the vehicle in a downward and inward direction. This type of vehicle can equally ride over ice, water, marsh, or relatively level land.

II. LITERATURE REVIEW

Design and Fabrication of Hovercraft - Vol. 4, Special Issue 6, May 2015 A.Anandhakumar, S.Ganesan, S.Goutham, K.Pasupathi

We observed a hovercraft is a self-propelled vehicle, dynamically supported by a self-generated cushion of slow moving, high pressure air which is ejected against the surface below and contained within a flexible skirt such that is totally amphibious and has some ability to travel over less than perfect surfaces. Propulsion is not derived from contact with the water or the ground. The hovercraft floats above the ground surface on a cushion of air supplied by the lift fan. The air cushion makes the hovercraft essentially frictionless.

V Abhiram, N Suman Krishna, T Murali Mohan Raju, M Anjiah – ISSN 2278 – 0149 Vol. 3, No. 4, October 2014

Observed the basic components and construction of hovercraft.

Lifting Fan: - Firstly the volume of air needed is very large and a propeller is designed to be most efficient in open air like on an aircraft. Also the fan needs to force air into the chamber below the craft so creating a specific pressure under the craft.

Hovercraft Skirt: - The skirt is Shaped, flexible strip fitted below the bottom edges of the plenum chamber slot. As the hovercraft lifts, the skirt extends below it to retain a much deeper cushion of air.

Lift System: - The hovercraft relies on a stable cushion of air to maintain sufficient lift. The weight distribution on top of the deck is arranged so that the air is distributed the air from the rear of the deck throughout the cushion volume in an approximately even fashion to provide the necessary support. The skirt extending below the deck provides containment, improves balance, and allows the craft to traverse more varied terrain

Thrust: - The lift forces generated by the engine i.e. leaf blower are used to create an air gap between the skirt and the ground surface. As indicated in the above lift calculations, the air gap generated is approximately 20 mm. As a result of air gap generation, the static and dynamic frictional forces are reduced immensely, because the co-efficient of friction of air is very low when compared to the ground surface. Thus, the thrust force required for propelling the hovercraft in the horizontal direction, is greatly reduced. Hovercrafts are generally simple mechanisms in theory.

Okafor - International Journal of Engineering and Technology Volume 3 No. 3, March, 2013

In this paper the design and development of a hovercraft prototype with full hovercraft basic functions is reported. The design process is quite similar to that of boat and aircraft. In-depth research was carried out to determine the components of a hovercraft system and their basic functions; and in particular its principle of operation. Detailed design analysis was done to determine the size of component parts, quite in accordance with relevant standard requirements as applicable in the air cushion model. Test performance was carried out and the prototype was found to meet design expectations giving an air cushion of 0.5 inch. The test performance result gave an efficiency of 69% for the design. Further research is recommended to improve on the efficiency of the craft.

A. K. Amiruddin, S. M. Sapuan and A. A. Jaafar – - International Journal of the Physical Sciences Vol. 6(17), pp. 4185-4194, 2 September, 2011 DOI: 10.5897/IJPS10.311 ISSN 1992 -1950 ©2011 Academic Journals5 19, 1994

The hovercraft prototype was constructed according to the aluminium hull base analysis. The characteristics of the hovercraft systems were based on the design chosen. Calculations were then made by the listing of these characteristics within the limitations of the materials and equipment available, location and the centre of gravity of the hull. The construction processes are as follows: hull base construction, load testing, seat and controller navigation installation, engine installation, blade and blade cover construction, preliminary testing, blower installation for lift system, skirt construction and testing.

Ashish Bhateja, Nirmalpreet Singh, Sukhdarshan Singh and Ravinder Kumar - IJCEM International Journal of Computational Engineering & Management, Vol. 16 Issue 1, January 2013 ISSN (Online): 2230-7893

The principle of working of a Hovercraft is to lift the craft by a cushion of air to propel it using propellers. The idea of supporting the vehicle on a cushion of air developed from the idea to increase the speed of boat by feeding air beneath them. The air beneath the hull would lubricate the surface and reduce the water drag on boat and so increasing its speed through water. The air sucked in through a port by large lifting fans which are fitted to the primary structure of the craft. They are powered by gas turbine or diesel engine. The air is pushed to the underside of the craft. On the way

apportion of air from the lift fan is used to inflate the skirt and rest is ducted down under the craft to fill area enclosed by the skirt.

Vasanthkumar. P, Vignesh. K, Rajkumar. G - Volume 4, Special Issue 2, February 2015 ISSN (Online): 2319 - 8753 ISSN (Print): 2347 – 6710

Hovercrafts work on the two main principles of lift and propulsion. When dealing with a hovercraft, the existence of lift is imperative for the proper function of the vehicle. Lift is an essential factor because it is that which allows the craft to ride on a cushion of air several inches off the ground. This process, the process of attaining lift begins by directing airflow under the craft. In order to quarantine the air under the air cushion, a skirt is required. This is done in order to create pressure under the hovercraft which forces the vehicle off the ground. Attaining the proper amount of airflow is imperative for the maintenance of the craft's stability. If too much airflow is directed under the craft, it will then hover too high above the ground, resulting in the hovercraft to tip. Not enough lift will cause the craft to remain on the ground which defeats the very purpose of the hovercraft altogether. The source of the airflow which propels the craft of the ground is a fan. The fan can be used for lift and thrust. It can be dedicated to lift or thrust or even both simultaneously.

III. PARTS

A. The Hull:

The Hull is a made by plywood that helps to mount all the components. We choose plywood as a hull material because its light in weight and it can carry more weight than other.

Fig. 1: Hull

B. Skirts:

Skirt is which is used bottom of the plywood and the air is filled in the skirt.Skirts provide cushion to the vehicle. By the cushion vehicle can transport easily. Air intake in skirts by using the compressor driven by engine and air floating away from the holes that creates cushion pressure.

Fig. 2: Skirt

C. Blower:

Blower is use to drive the compressor that create Air pressure inside the skirts. The capacity of the blower is 230V and 13000rpm.

Fig. 3: Blower

D. Control Panel:

Control Panel is use to control the cushion pressure and engine speed. It also helps to give the direction of vehicle.

IV. CALCULATION

A. Parameter of Skirt Dimensions:

a) Cushion Pressure (Pcu)

- Pcu = F/A = 245/0.5 = 490 N/m^2
- Area = length×Width = 1×0.5 = 0.5 m^2
- Force = 25×9.8 = 245 N

b) Bag Pressure (Pbag)

- Pbag = 1.3 Pcu = 1.3×490 = 637 N/m^2

c) Air Velocity Through Holes

- Vexit = $Dc\sqrt{(2 \times Pcu)/(\delta air)}$ = 14 m/s { δair= 0.53 }

d) Area of Hovergap

- Ahovergap = L×H = 0.0075 m^2 { L = perimeter H = Hovergap }

e) Flow Rate

- Q = Ahovergap × Vexit = 0.105 m^2/s

V. OPERATIONS

A. Material Selection:

According to the requirement of the working model of our project, the selected materials are:

Serial No	Component Name	Material options	Selected material	Dimensions
1	Hull or Base	Plywood plate, Plastic	Plywood	Length = 1m Width = 0.5m

2	Motor	Engine, blower	Blower	Engine = 1 HP, Blower=230 V, 600W,13000 RPM
3	Skirts	Rubber, plastic , Paper silk	Paper silk	Length = 1m Width = 0.5m

Table 1:

B. Machining Process:

- Finishing of Hull using shaping machine and creating fillets to the corners.
- Generating Hole on Hull using hand drilling machine for fixture of blower.
- Attachment of skirt using adhesive material under hull.
- Creating Hole on Skirt by heating process for the air discharge from the skirt cushion.
- Attachment of Blower on top of the hole on hull using adhesive.
- Attachment of wooden square section below hull over the skirt to equally distribute the compressed air from the blower.

C. Assembly:

After all the machining processes all the components are assembled according to the design of the project.

Fig. 4: Air Suspended Vehicle

D. Testing:

After assembly testing of working model is done. Some parameters for testing:

- Check all components assembled properly
- Proper working of model
- Check maximum load carrying capacity
- Finding and preventing of air losses
- Conditions for failure

VI. RESULT ANALYSIS

By adopting Taguchi method, we get the 9 set of parameter.

Modification	Force	Skirt length(l)	Skirt Width(W)	Cushion Pressure (N/m^2)
1	25	1	0.5	490
2	25	2	1	122.5
3	25	3	1.5	54.44
4	27	1	1	264.6
5	27	2	1.5	88.2
6	27	3	0.5	176.4
7	29	1	1.5	189.46
8	29	2	0.5	284.2
9	29	3	1	94.73

Table 2:

By using minitab-16 software, insert the 3 factors and 3 levels in taguchi design of experiment method got the following array and design of steps to perform experiment we get two different graphs.

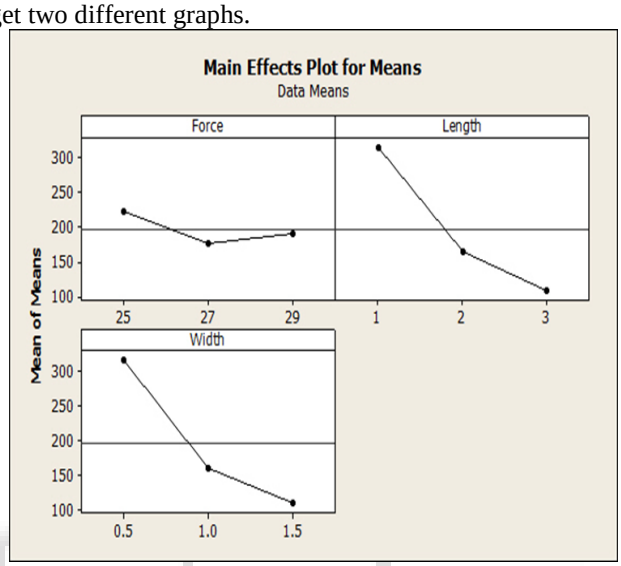

Fig. 5: Main Effects Plot for means

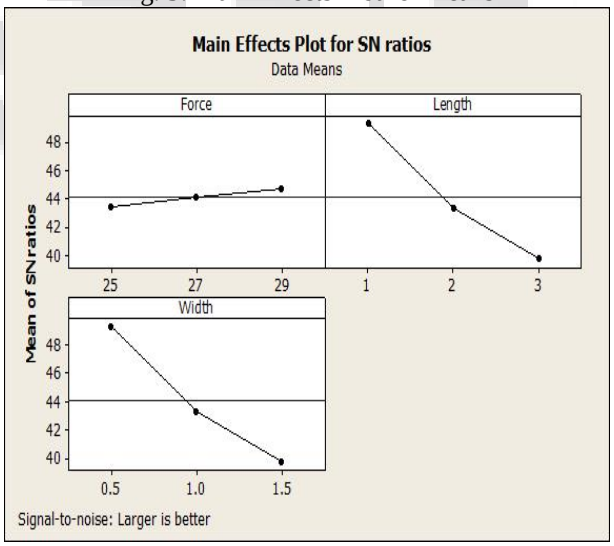

Fig. 6: Main Effects Plot for SN ratios

VII. ADVANTAGES AND DISADVANTAGE

A. Advantages:

- It is friction less transportation method.
- It reduces the men effort significantly compare cart.
- It is suitable for small industry where flow space is very less.
- Its eco-friendly mode of transportation.
- It is easy to handle.
- It is less complex in design.
- The maintenance is easy.

B. Disadvantages:

- Load capacity depends on input parameters, for low input power the capacity is low.
- The stability of vehicle is less.

VIII. CONCLUSION

With all the above literature survey, component design and measurements we came to know that our working model of air suspended vehicle for internal transportation purpose can carry 25Kg load. Also it is frictionless compare to cart and other load carrying system. In small industries where flow area is less our working model is more useful than high-end machineries. In Minitab, using Taguchi's method, with input parameters like hull dimensions, skirt dimensions and force generated by blower we get the output parameter which is cushion pressure. The variation on input parameters affects on the output parameter which is shown in result graph mentioned above. According to our design the selected input parameter are shown in table above. The variation in blower capacity affects lifting and cushion generated in the skirt. By increasing all the input parameters and blower capacity we can increase the efficiency of the working model.

REFERENCES

[1] Amyot J. R. (1989). Hovercraft Technology, Economics and Applications. Elsevier Science Publishing Co., New York.
[2] Kerrington E. (2011). Hovercraft. http://www.kerringtontyler.blogspot.com
[3] McPeak M. (2004). History of Hovercraft. http://hovertron.tripod.com/images/mpaper.pdf
[4] Nakamura H, Kayanuma H, Kimura S, Kosugi M (1997). A new process for small boat production. J. Mater. Proc. Technol. pp196-205.
[5] Paik JK, Duran A (2004). Ultimate strength of aluminum plates and stiffened panels for marine applications. Mar. Technol., 41(3).
[6] Paik JK, Veen SV, Collette ADM (2005). Ultimate compressive strength design methods of aluminum welded stiffened panel structures for aerospace marine and land-based applications: A benchmark study. Proc.Thin-Walled Structures. pp 1550-1566.
[7] Spedding S.G. (2001). History of Hovercraft. http://www.hovercraft.org.uk

