

Development of Efficient Animal Driven Vehicle to Reduce Animal Drudgery

P. V. Lande¹, P. S. Kadu², D. M. Mate³

[#]Department of Mechanical Engineering, Priyadarshini College of Engineering, RTM Nagpur University, India

¹ pratiklande@gmail.com

² pskadu@gmail.com

³ dmmate@gmail.com

Abstract— Focus of this paper in to study the development of efficient animal driven vehicle to reduce animal drudgery. It includes different physiological studies, in the field of yoke design, perspiration and pulse rate with respect to different loading conditions and body temperature, rate of salivation with respect to speed of bullock and working hours. This shows that by use of proper transmission bearings, suspension system, flywheel and breaking system along with improved pulling beam efficiency of animal can be increases substantially.

Keywords— Biological energy, Mechanical Advantage, Bullock cart, Traditional Rural transport, physiological study of ox.

I. INTRODUCTION

There are over 13 million animal driven vehicles (ADV's) in India. These includes the carts yoked to bullocks, buffaloes, mules, horses and even camels; however 90% of them are the ox driven carts (Bullock carts). Bullock Carts have been used especially in country side as primary means of transporting food grains, crops etc. since very early ages. Unfortunately, it could not avail the advantages of technological development as being taken place in other areas of transportation. The average fright carried by the bullock carts is much more than the fright carried by the Indian Railways and motorized road transport. Bullock carts remain depending on concept and design of very primitive stage over generations. There has been a little effort in improving the designs though 80% of the bullock carts are of conventional type. These carts have high transmission losses and inefficiencies. Though there has been technological development in the areas such as engineering technology, medical science, and space science but unfortunately there is very little research on the bullock carts. No data is available on the effect of carrying such heavier loads on the neck of the bullocks and their life.

There is no significant research carried out on efficient bullock cart in view of better load carrying capacity, better body design, wheel diameter, use of suitable type of suspension system. This paper deals with development of efficient bullock cart in view of the above mentioned requirement. In this paper it is proposed to develop a suitable

bullock cart and analyze it using design software and then experimentally.

II. PROBLEM IN PRESENT DESIGN

Now days though steel based bullock carts are available but there have not been any change in the design of the bullock cart. The utilization of animal energy is not properly transmitted to the wheels. Due to uneven terrain centre of gravity of the cart gets shifted frequently and causes excessive load on the animal neck which in terms leads to low load carrying capacity. This heavy load causes heavy strain i.e. vertical load and the neck abrasion causing injury. The internal injury corresponds to formation of tumour inside the neck muscle which may lead to the cancer. The efficiency of the bullock cart is very less and it has got a very less mechanical advantage.

III. LITERATURE REVIEW

As significantly less research has been done on this area very less scientific data is available for comparison.

A. Effect of yoke design on neck load

The efficiency of the transmission depends upon the contact area and the distribution of the load at the contact area between the neck and the yoke. Working efficiency of the draught animal is mainly dependent on the load distribution pattern occurred due to the area of contact of the yoke. The study was conducted to find out the load distribution pattern of the Malvi breed with the traditional and improved Nagpuri yoke. The load cells were used and the contact was calculated by marking black and white colour on the neck and the yoke respectively. The load distribution was also recorded at the left side pad and right side pad. The mean contact area for improved Nagpuri yoke was found to be 37.84 x 28.68 mm (588.88 cm²) and

that for local yoke was 15.56 x18.21 cm (493.552 cm²) at 1000 N load. In the experimental test track it was found the vertical load on the neck of the bullock was higher and went on reducing from right to left side of the yoke pad. The mean loads on the neck of bullocks on contact surface of Nagpuri yoke were significantly less in comparison to local yoke. Thus the Nagpuri yoke was found to be more efficient, more suitable for carrying higher load and more comfortable to the bullock.

B. Physiological study of ox for different loading condition.

The research carried out by reference [2] involve study of different carting loads and ploughing and planking operations was undertaken to estimate the work stress of ploughing and planking on carting load scale in working bullocks. The Horse power generated, pull exerted, the increase in the physical reflexes and the rate of increase in salivation as the increase and prolonged working stresses was observed for different types of load. Trails were taken using 6 kankrej and 6 cross breed of kankrej and jersey bullocks. The bullocks were subjected to 3 hours session work including ploughing and planking with total pay load ranging from 150%, 200%, 250% & 300% of body weight of bullock. The pull exerted and Horse power generated was observes an found to be 23.56 kg, 36. Kg 64 kg, 47.08 kg, 56.72 kg, 44.27 kg and 21.72 kg and 0.35,0.53 0.67, 0.80, 0.54 & 0.26 respectively.

C. Physiological study for body temperature and perspiration rate

A comparative study was conducted to assess the draught ability of the local bullocks available in Orissa in test track and field condition in summer. The test track study was conducted with the help of CIAE loading car at draught equivalent to 10, 12 and 14% of bodyweight of the bullocks (620 kg)PR and RR increased significantly ($P < 0.01$) with duration at all draughts both in test track and field condition. The increase in RR is brought about to meet the energy demand at different draughts (level of work) whereas the increase in PR represents a rise in cardiac activities to fulfill the increased demand of oxygen during work. Sudden rise of both PR and RR might be to meet the immediate energy need to carry out the work. This trend was also observed by Singh et al. (1968), Devadattam and Maurya(1978) and Acharya et al. (1979). The interaction between types of surface (test track and field) was significant ($P < 0.01$). Higher PR and RR on field might be due to difficult terrain condition. The body temperature increased significantly ($P < 0.01$) with duration both in test track and in field at all draughts. The increase in BT with duration might be due to more heat set free on account of increased lactic acid production by the muscles and

its removal by oxidative process. This is in agreement with the findings of Singh et al. (1968), Devadattam and Maurya(1978) and Chhikara and Singh (2000). The rise in BT is a physiological necessity to increase the rate of chemical process to decrease internal friction resistance in muscles and to supply oxygen to the working muscles (Astrand and Rodhal 1970). The speed of bullocks decreased significantly ($P < 0.05$) with increased duration of work in all draughts both in test track and field. In field, it was greater than that in the test track at all duration and draughts. Draught being constant for a particular surface, the power output is a function of speed of bullocks. Hence, similar to the speed, the power output decreased with duration at all draughts. The variation of power output is attributed to the variation in speed of the bullocks. As the speed decreased in the field compared to test track, the power output decreased which might be due to difficult terrain condition in the field. In field the bullocks has to work on soft undulated soil whereas in test track bullocks walked on plain tar road. Also, pulling a loading car with pneumatic tyre is easier than pulling a plough or disc harrow where there is an accumulation of soil ahead of the implement. This requires the bullocks to exert more in the field.

IV. PROPOSED SOLUTION

More comprehensive analysis which includes the study of the effect of gradient of the terrain, variation in the horizontal and vertical disposition of the centroid of the loaded cart, size of the wheels etc. on the design and the performance of the cart. In order to make cart more efficient in transmission, proper bearings should be used to reduce friction between the axle and the wheels. Use of suspension system can also be made to increase the life of the bearing. Also better design of the pull beam (an innovative mechanism with suitable degrees of freedom to reduce vertical load on animal neck) can increase in proper utilization of the animal energy, making the cart more efficient. The use of flywheel in cart can assist the oxen in running condition. The gearbox can be employed to magnify the motion imparted to the wheels or vice-versa. While doing so the care must be taken to provide brakes. While the cart going down the hill there is excessive load on the animal neck, as in the traditional bullock cart there is no such kind of provision, the ox has to apply additional effort in reducing the speed of the cart. 3 to 4 wheels can be used to reduce the vertical load on the animal neck. The height of the ox and the diameter of the wheel plays an important role in the tractive effort applied by the ox. The implementation of all these measures can considerably reduce the strain on the animal neck and increase the load carrying capacity and efficiency of the cart.

D. References

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V. CONCLUSIONS

The In due study of the papers mentioned above it is brought in notice that, the research on bullock is conducted considering different loading condition at different region in different working condition and of different breed. The horsepower output of different breeds differ depending on the loading conditions. The results obtained from the field trials and the test rack varies a little bit. Improved Nagpuri yoke has been found very effective, comfortable and has more area of contact with the neck, All the above papers deals in reaserch carried out on bullocks however a few research is carried out on the bullock cart. The proposed research is intended to derive following results

- 1) The relation between the inclination of cart to the ground and the diameter of the wheel is to be found out and the effect of various wheel diameters to neck

load is to be analyzed. The relation will provide the exact amount of neck load, due to the combined effect of goods load and the shifting of CG.

- 2) With the use of innovative joint for pull beam, the direct load on neck (i.e. neck load) will be considerably reduced.
- 3) The tractive force applied by the ox can be used effectively in pulling the cart.
- 4) The use of appropriate bearings will considerably reduce the transmission losses while transmitting the power from ox to the cart wheels.
- 5) The use of suspension will ensure the life of bearings.
- 6) The use of flywheel will assist the oxen while climbing the uneven terrain.
- 7) The use of breaks will be very useful for ensuring the cart stability and minimizing the discomfort to the bulls while running down the hill or on the terrain with very low coefficient of friction.

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