Donkey cart axles and harnessing material development in South Africa

by

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Abstract

Most donkey carts in South Africa are built using scrap vehicle axles which are heavy and, compared to the price of a donkey, expensive. A lightweight axle made from widely available, easily obtainable, cheap material was developed by the Institute of Agricultural Engineering (South Africa) and tested in the field. The axle is made from two sections of round bar, two lengths of Y-section fence pole, a few pieces of flat metal plate and two pieces of pipe. The axle is easy to manufacture and uses no bearings or bushes other than the round bar turning in two pieces of tightly fitting pipe. When the axle is badly worn after a period of use it can be recycled and a new one can be made by a rural blacksmith using only gas cutting equipment, a drill and a welding machine.Good leather harnesses are expensive and difficult to obtain, so farmers make harnesses from other materials. These harnesses are often poorly designed and wire is used for fixing the harnesses which causes unnecessary chafing of the animals. The use of alternative materials, such as old drive belts and reject safety belts and fire hose, is being researched by the Institute, and two harnesses have already been made from fire hose and old drive belt: the strips are fixed together using a sewing awl and thread as well as rivets.The harnesses work well, but the rivets are difficult to obtain.

Introduction

During 1994 a national survey on the use of animal traction in South Africa was carried out for the South African Network of Animal Traction (SANAT). This survey found that between 40 and 80% of households in certain areas of South Africa use animal power for transport and/or cultivation (Starkey et al, 1995). Following recommendations in the report on aspects of animal traction which needed to be studied and developed, the Institute for Agricultural Engineering within the Agricultural Research Council of South Africa launched a programme to design a lightweight, cheap axle for a donkey cart and to investigate alternative materials and methods for making harnesses for donkeys.

Cart axles

Need for a new axle design

Most donkey carts currently used in South Africa are built with scrap motor vehicle rear axles. These axles are available from most scrap yards, they require little running maintenance, and, if they are obtained together with the springs, the cart body (with a wooden framework) can easily be fitted onto the axle without the need for welding. However, the axles are heavy (70 kg) and theprice varies greatly, depending on demand and supply (Starkey et al., 1995), up to R600

(US$1.00 = R3.60). Carts for single donkeys are rarely seen in South Africa. Those that are used usually have lightweight axles because the use of heavy motor vehicle axle increases the cart's overall weight and hence decreases its carrying capacity.

Animal-drawn carts have been used and improved for many years. Instead of duplicating work already done on the design of donkey carts, the Institute decided to develop a lightweight axle which could be manufactured using the absolute minimum of tools and cheap, locally available materials. The use of bearings or bushes was considered, but abandoned because they are expensive and need machining.

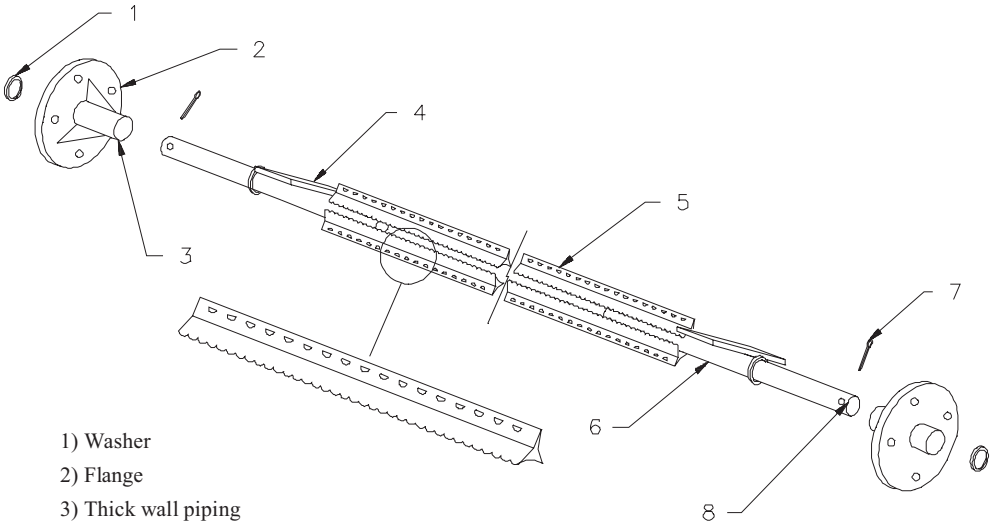
It was originally intended that most rural farmers should be able to make the axle, but this is not possible as the materials and components are not easy to obtain in remote rural areas. The emphasis therefore shifted to the rural blacksmith or artisan who has access to a cooperative or hardware shop from which to buy the metal, and access to electricity for welding The axle had to be cheap enough to be replaced entirely when worn out after a period of use. Although bearings or replaceable bushes are not used, the life of the axle can be extended considerably by frequent lubrication.

The total cost of the axle material is less than R100 and the weight is 14 kg. This means that the axle can, after it is worn out, be recycled and a new axle can be bought or made. As the cheap axle brings the total cost of the cart down it should make owning a cart much more affordable. The lightweight axle also makes it feasible to obtain a reasonable payload with single-donkey carts. The axle can either be mass produced or manufactured by an individual for his own use and it was designed in such a way that only a drill, a welding machine and gas cutting equipment need to be used. It is envisaged that entrepreneurs will grab this opportunity to start small businesses.

Construction of new axle

The construction of the axle is very simple. It consists of only three main parts–the "beam" and the two flanges into which the beam fits (Figure 1). The beam is made of two lengths of ordinary Y-

Figure 1: Design of the lightweight axle



1) Washer
2) Flange
3) Thick wall piping
4) Mounting plate for cart frame
5) One length (1,84m) Y-section fencing pole cut in half
6) Shafting
7) Splitpin
8) Splitpin hole

section fencing pole welded together lengthways, with two pieces of shafting welded into the two ends. The reason for using fencing pole is that it is very cheap (even when new), and its Y profile makes it very strong.

No machining is required and the materials that were selected for the manufacture of the axle are very easily obtainable. As the design is not restricted by having to use fixed sizes of material for the beam and the pipe in which the shafting fits it allows for some deviation from the given sizes.

The flanges onto which the rims are bolted consist of a piece of round flat plate with a hole in the centre into which a length of pipe is welded. As a "dead" axle is used (the axle does not turn) the flange runs on the shafting and is smeared with grease for lubrication. Once again the flexibility of the design allows the manufacturer to match the number of holes in the rims he has to the number of holes he needs to drill in the flange. This means that several different types of rims can be used. Changing a wheel or lubricating the axle can be done without the need for any tools as the wheel flange is secured onto the shafting by using split (cotter) pins. A piece of flat plate with two holes through it for fixing the cart body to the axle is welded on the shafting.

No bearings or bushes are used and the axle is lubricated with grease or any other sort of lubrication such as animal fat. It is true that the shaft and wheel flange will wear much faster than a sealed bearing, but a compromise had to be struck between this design and factors such as price and ease of manufacture.

Harnessing

Current status

The vast majority of harnesses used on donkeys in South Africa are poorly designed, inefficient and sometimes even cruel (Starkey, 1995). The problem lies partly with the attitude of some of the users towards donkeys, but is mainly that good quality commercially manufactured leather and nylon harnesses are very expensive. A new leather harness for a donkey can cost up to R600, but most donkeys cost less than R50. Comparing this to the cost of yoking six oxen, which is approximately R600 for the yokes and chains, it becomes clear why people use whatever material is available to make donkey harnesses. Harnesses made from nylon webbing are not easy to obtain and are usually used on more expensive animals such as horses.

Another problem with leather harnesses is that they must be well looked after and oiled regularly to prevent them from becoming hard and brittle. Cattle are still kept in many areas of the country as a symbol of wealth or for religious purposes. If a farmer knows how to tan and work leather, harnesses can easily be made from hides of local cattle at a very low cost, thus allowing regular replacement of worn-out harnesses as an alternative to the kind of special care that would prolong the life of the harness. Unfortunately there are very few farmers left with leather-working skills. Farmers therefore usually resort to making their own harnesses from any available material such as rope or hard conveyor belting. Very often the strips are cut thin or wire is used to fix the harness. This leads to excessive chafing and bruises. In many cases the harnesses are made for a specific animal of a particular size. When another animal is used the harness does not always fit properly and again significant discomfort is caused to the animal. It is interesting to note that in most cases no breeching strap is used to assist with braking and the animal is forced to stop the cart by lifting up its neck.

Alternative materials

The Institute decided to look at suitable materials for making harnesses, and at methods of fixing the strips together without using wire. Three alternative materials were investigated: old threshing machine drive belts, reject motor car safety belts and reject fire hose.

Old drive belts

Drive belts were used with tractors to drive threshing machines and hammer mills before the invention of the power take-off shaft. These belts usually consist of several layers of material, which can be separated until the required thickness of material is obtained. The strips can easily be cut and sewn together, but fitting rings or buckles is difficult, because the layer has to be quite thick to be strong enough, and when it is folded double round the buckle or ring it becomes difficult to sew.

Unfortunately this type of belt is not commonly found on farms any more. Several industrial factories were contacted to obtain ordinary conveyor belting, but this is too thick and hard and is usually made of rubber which will cause the animal to sweat.

Reject safety belts

Reject safety belts can be obtained from the manufacturers, from motor car factories and from scrap yards, (although some scrap dealers are reluctant to sell the belts separately, and so charge high prices for them). For its thickness, the safety belt is very strong, but the edges are hard and sharp, so unless the harness is well padded, especially in the breastplate area of the harness, it might cut into the skin of the animal.

Reject fire hose

Reject, or used, fire hose can be obtained from almost any fire station. The single ply hose cut into strips is very strong for its thickness: it can easily be sewn together, even where buckles or rings have to be fitted. The only drawback is that the inside of the hose is covered with a thin layer of plastic which may cause sweating. This can be overcome by placing the outside of the hose on the skin of the animal.

Manufacturing of the harnesses

When making harnesses there are a number of difficulties which may be encountered. In order to prevent chafing and wounds, harness parts must be of sufficient width and attached appropriately to one another.

Width of the strips

The width of the strips is an important factor to consider when making a harness, especially in the areas where the greatest force will be exerted such as on the breastplate. The amount of padding used should not be too little, so that the animal is chafed, or too much, as this might restrict breathing. If the material is not very strong a double strip should be used. It is important to ensure that the breast band is not too wide as this may cause choking and ineffective pulling. he strip that goes over the neck of the animal (especially for a double donkey cart with one shaft) should be wide enough so that it does not cut into the neck if the load is not balanced correctly. Using a rope instead of wide flat material such as safety belt is not recommended.

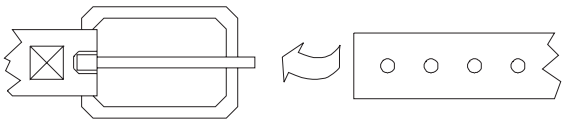


Figure 2a: Buckle

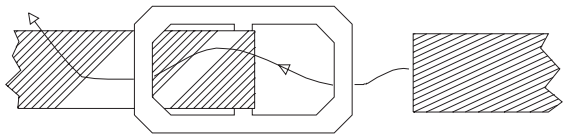


Figure 2b: Buckle without needle

Connecting the strips

Pieces of wire are often used to repair a broken harness. Using a sewing awl and thread is, however, an easy and more humane method. Obtaining the sewing awl may be difficult in remote areas, so a sharpened piece of metal or a nail may be used to make holes in the material and an ordinary thick needle and thread can then be used. As in the old days rivets can also be used, but these tend to be hard to obtain, even in the cities.

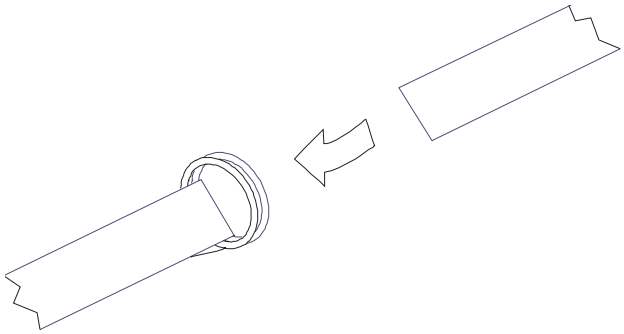
Adjustability and attachments

If the harness is not made for a specific animal some sort of buckle will be needed to allow for adjustments to accommodate animals of different frame sizes. It is also expedient to connect the breeching strap to the front of the harness by buckles. Ordinary buckles (such as the type used for trouser belts, see Figure 2a) have several drawbacks: they rust easily, they are expensive, and the holes required for the buckle needle weaken the material. Other types of buckle (see, for example, Figure 2b) do not have these drawbacks, but these are not easily obtainable and are difficult to make at home.

One type of buckle which is useful is the type used on motorcycle helmets (Figure 3). Two rings are fitted to the end of one strip of material, and the other strip is threaded through these rings. This method works very well for all applications over the harness, except where the chains from the implement or cart connect to the harness Here a considerable tractive force is exerted and the traces tend to pull out of the buckle. To overcome this problem the harness can be made in such a way that the traces that connect to the implement or cart are made contiguous with the front of the harness, thus eliminating the need for buckles.

Using this method, where harness and traces are integrated, creates the problem of fixing the traces to the swingle trees. Where chains or ropes are used as traces there is no problem fixing them to the swingle tree. However, when the traces are made of flat belting, which leaves the side of the animal in a vertical manner but then has to be connected to the swingle tree horizontally to avoid having to make modifications to the swingle tree, the bend in the strips causes the sharp edge of the material to be near the skin of the animal. This leads to unnecessary chafing. To overcome this problem the strips of belting are folded double from where they leave the side of the animal to where they are connected to the swingle tree or cart.

Figure 3: Motorcycle-type binding



If the breeching strap does not form part of the front of the harness, eyelets can be sewn onto the side of the harness onto which the

pulling strings can be attached. Connecting the traces to the cart can be done in several ways, one of which is shown in Figure 4.

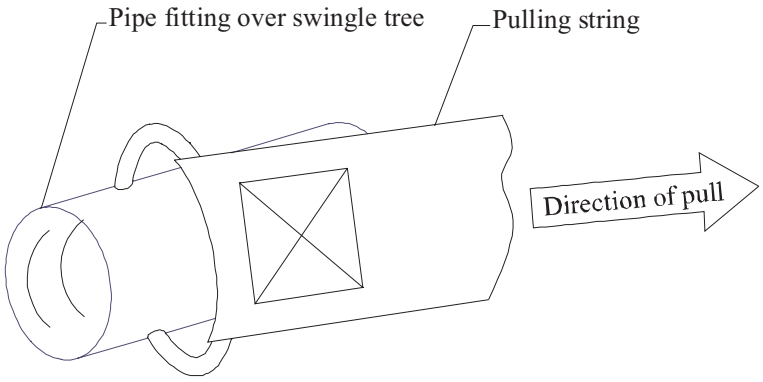


Figure 4: Fitting the pulling strings to the swingle tree

Conclusions

A lightweight, simple, durable cart axle, suitable for single or double donkey carts, was developed. It is anticipated that this axle can be made in rural areas of South Africa by local blacksmiths at a reasonable cost, using locally obtainable materials. Widespread distribution of such an axle could allow many more farmers to own and use donkey carts. Manufacturing a harness is not difficult and it can be done by almost anyone with a few basic tools and a little know-how. Obtaining suitable material is not always easy but by making the harness correctly a very wide variety of material can be used. It is important to make sure that the harness fits and that it does not chafe the animal during work. Adoption of the new cart axle design, combined with greater attention to the use of appropriate materials and construction of harnesses, may improve efficiency of draft donkey use in South Africa.

Acknowledgements

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References

Starkey P, 1995 (ed). *Animal power in South Africa: empowering rural communities.* Development Bank of Southern Africa, Gauteng, South Africa. 160p.