

KENDAT



Low-Cost Animal Cart Programme

Twin Plastic Plain Bearing Axle for Donkey Carts

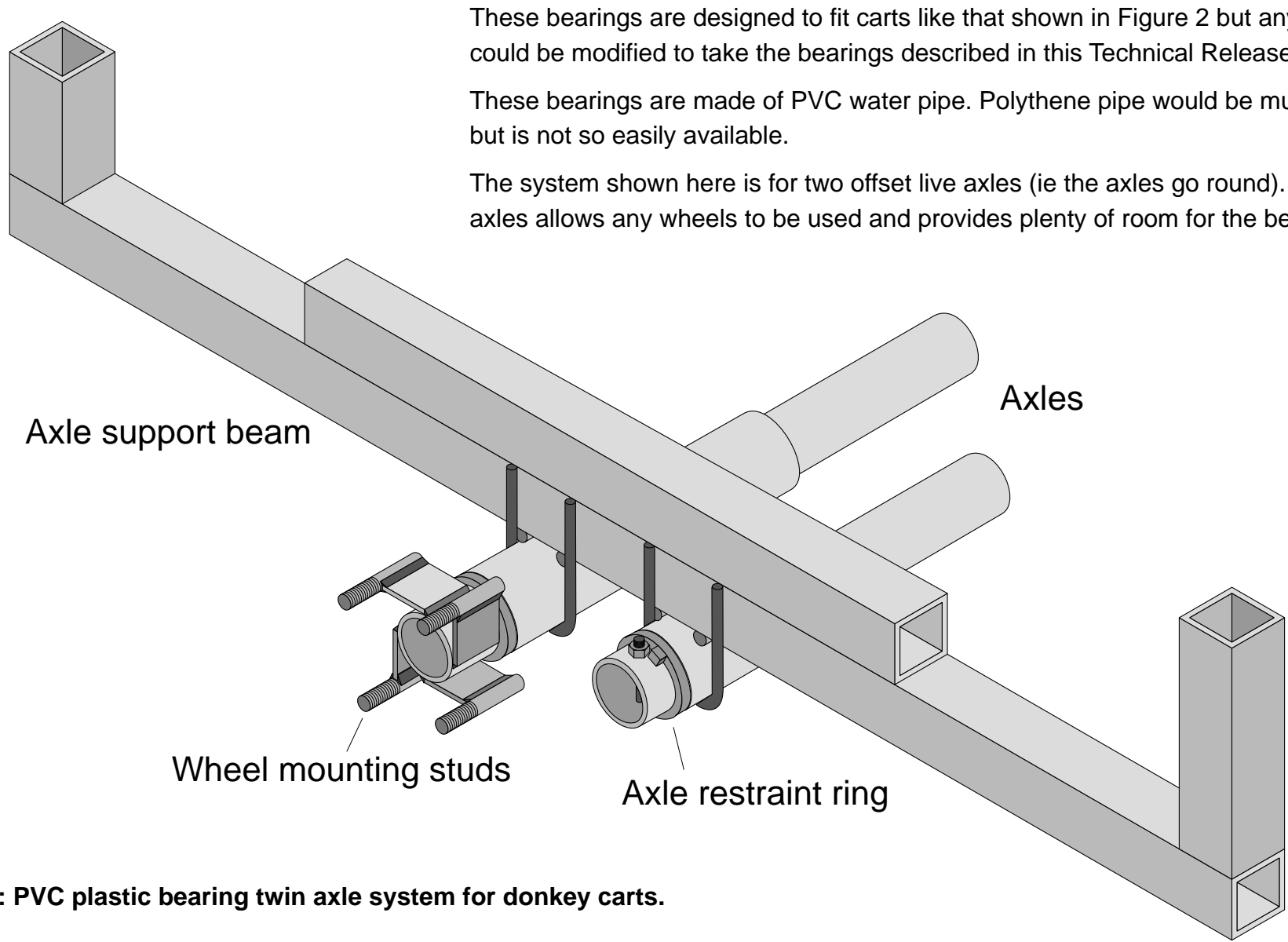
TECHNICAL

36

RELEASE

Development Technology Unit, Department of Engineering, University of Warwick, Coventry, CV4 7AL UK, tel: +44 (0)203 523523 extn 2339, fax: +44 (0)203 418922, email: esceo@eng.warwick.ac.uk

KENDAT, PO Box 61441, Nairobi, Kenya, tel/fax: +254 2 766939, email: kendat@africaonline.co.ke



These bearings are designed to fit carts like that shown in Figure 2 but any cart could be modified to take the bearings described in this Technical Release.

These bearings are made of PVC water pipe. Polythene pipe would be much better but is not so easily available.

The system shown here is for two offset live axles (ie the axles go round). Using two axles allows any wheels to be used and provides plenty of room for the bearings.

Figure 1: PVC plastic bearing twin axle system for donkey carts.

PVC plastic sleeve plain bearing axle system for a donkey cart.

Introduction

In this booklet we tell you how to make an axle system for a simple donkey cart from round steel tube and PVC plastic pipe. The instructions do not cover how to make the cart itself - you

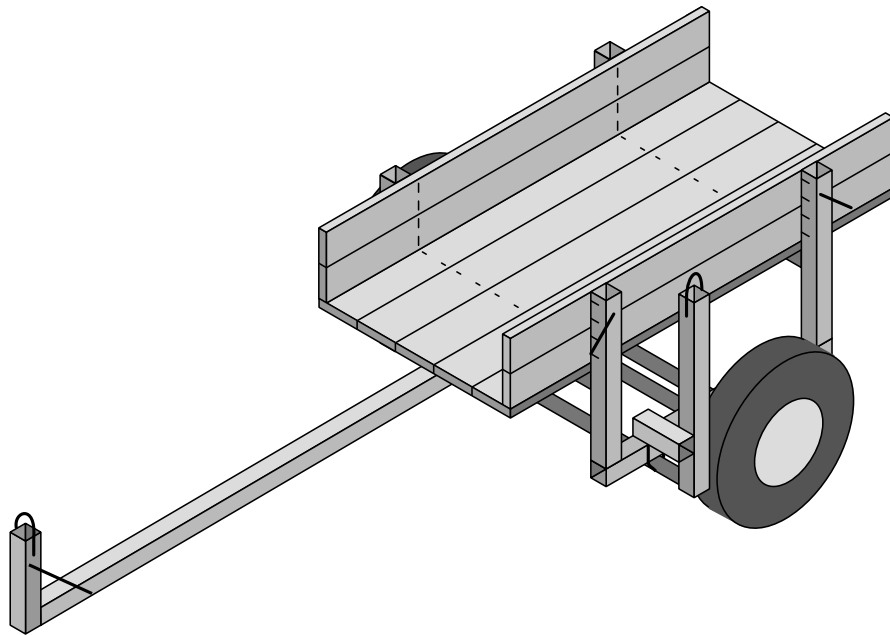


Figure 2: DTU donkey cart fitted with twin axles and PVC bearings.

TR36: 15th April 1999

will need to read other Technical Releases from us to find out how to make the carts.

You should find that you can make the axle system for about £50 including the wheels, tubes and tyres. This cost will depend on the cost of the materials and labour. Once you get organised, two men can probably make and fit one cart with axles in half a day. This is quite a lot faster than it takes to find and a scrap car axle and it will be much cheaper.

In other booklets in this series you can find out how to make other low-cost axle systems and carts.

CONVENTIONAL HALF LENGTH AXLE

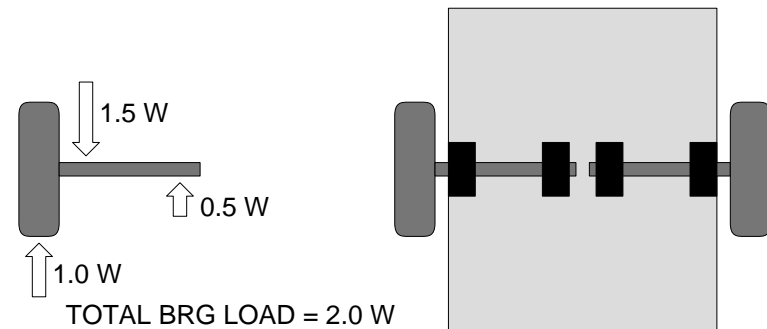


Figure 3: bearing loads in conventional half shaft axle.

Why have twin axles?

There are two types of axle: fixed or stub axle - the wheel hub rotates on the stationary axle; live axle - the axle revolves in stationary bearings.

With the stub axle types the bearings must be inside the wheel. This is easy with expensive ball bearings but more difficult with cheap wooden bearings. You need to make them quite long to stop wheel wobble and so they stick out of the wheel. It is also quite difficult to make without jigs and special tools. If you really want that type we have quite a good system using PVC tube for the bearing. We can send you a Technical Release on how to do it.

Twin axles allow much bigger bearings and do not require great

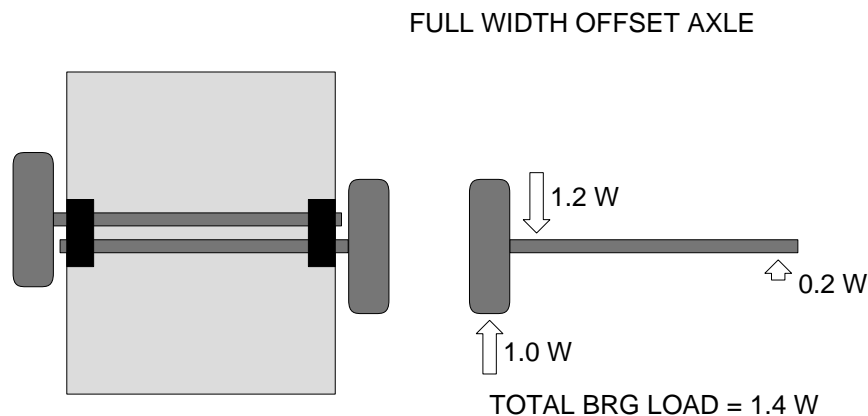


Figure 4: bearing loads in twin offset axles.

TR36: 15th April 1999

accuracy in manufacture. Figure 3 shows the bearing loads of the usual way of doing it and Figure 4 shows the DTU method. You will see that bearing loads are 30% lower. Surprisingly there is no extra steel required either because there would have to be some steel to support the middle bearings anyway.

Easy to make design

These axles are designed to be constructed without any special tools and jigs, and without any hard-to-get materials. The only tools which you must have are a simple welder, a hacksaw, and a hammer. You might find that a couple of 4" or a 5" G clamps (or something like it) are useful too. We have deliberately designed the cart so that drilling is not required.

You will see that there are no mitres or complicated angles or joints to cut when making the axles either, so you save time. Also the exact lengths of the components are not very critical -

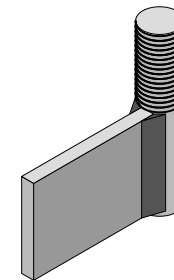


Figure 5: a welded wheel stud and strut fabrication.

again it saves a little time, but you will find that the axles look better if you take a little trouble to get things square and even etc and welding is easier with good square ends. It is much better to use a try square to mark the position of a cut than guess. In the instructions we have described how to mark pipe so you can cut it accurately.

We have tested many of these axles in Kenya and Uganda and we have had only a few failures caused by poor welding or incorrect material ie too thin. We think that they are strong enough, but you can always find someone to break anything. Really to get a reasonable cost you need to experiment a bit to

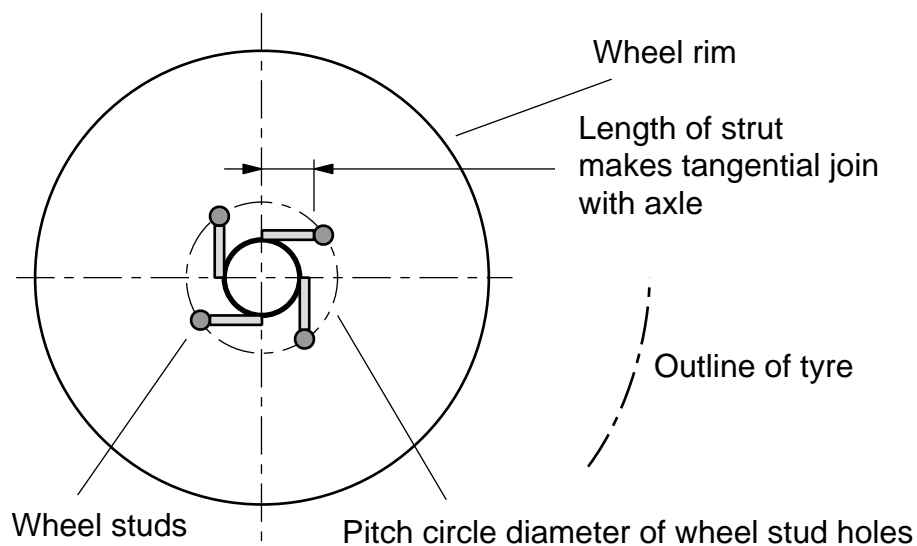


Figure 6: length of wheel strut.

see how the farmers treat their carts and what they expect them to stand.

It is also important to check the plastic sleeve is not worn through and to grease it every few weeks.

Cutting list and costs

Table 1 shows a cutting list for a complete axle - Recent prices of materials in Kenya are shown converted into £UK.

Construction step by step

1) The first job, is to get all the material together and clear a

TABLE 1: 50x50 RHS vestigial donkey cart.

component	material	# lengths reqd [#xmm]	total material for one axle [mm]	cost [UK£]
wheel studs	50xM12 nuts and bolts	10	10	2.60
wheel stud struts	6 x 40 flat bar	10x65	650.00	0.49
axial thrust rings	10 x 10 square bar	4 x 200	800.00	0.25
pipe clips	50 mm pipe clips	4	4	2.40
axle cross bolts	75xM12 nuts and bolts	4	4	1.04
axles	1-1/2" BSP malleable iron pipe	2 x 1500	3000.00	6.00
hub outer tube	2 BSP malleable iron pipe	2x200	400.00	0.95
plastic bearing sleeves	1 1/2" or 2" PVC plastic pipe	2x300+2x100	800.00	0.53
wheel rims, tyre + tubes				25.00
			TOTAL =	39.25

space to work. Ideally you will be able to work on a flat area of concrete.

- 2) Start by making the wheel stud struts shown in Figure 5. You need to make one of these struts for every stud hole in the wheels you are going to use. Figure 6 shows how to measure the length of the struts. The struts are made from 6x40 flat bar and M12 bolts 50mm long. The flat bar should be long enough so that it meets the axle tube tangentially as shown in Figure 6.
- 3) Once you have made these struts, screw a nut onto each one until it touches the 40x6 metal. Then put the thread through the hole in the rim and screw another nut onto the thread. Tighten this nut lightly with a spanner. Repeat for all the struts so that they all point the same way round the axle, as in Figure 6, and leave a gap for the axle.

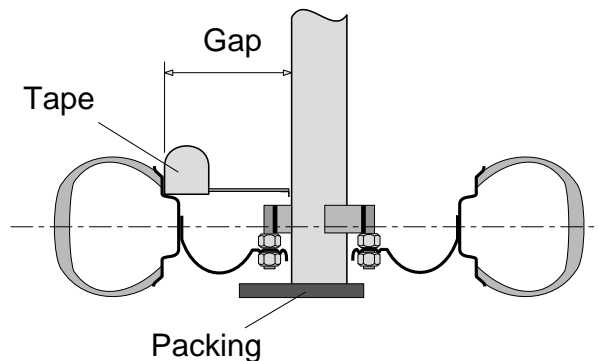


Figure 7: using tape measure to centre axle in wheel.

- 4) Now centre the axle in the rim and get it square using a tape measure, a trysquare and a plank or piece of steel resting on the tyre.

To do this put the wheel rim on the floor and put the axle in place in the middle. You should put something under the end of the pipe to rest it on to get it in the right position as shown in Figure 7. Get an assistant to hold the top end of the pipe and tell him to keep very still! Use your tape to measure from the outside of the pipe to the inside of the rim as Figure 7 shows. Measure in one place and then measure the gap opposite. Move the axle pipe over until it is central. Repeat this for the other direction at right angles.

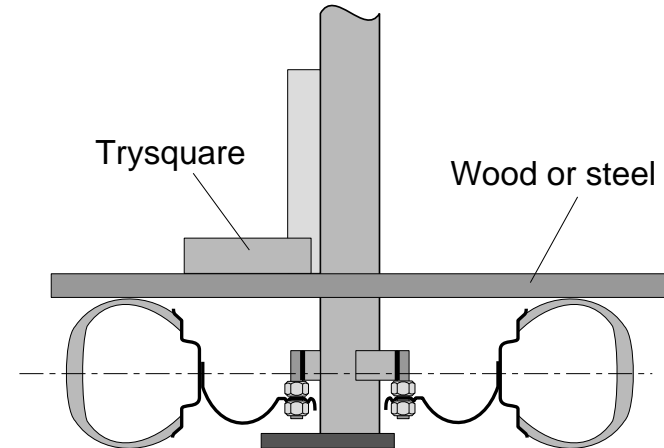


Figure 8: using trysquare to get axle square to wheel.

Now use the try-square and a piece of wood to get the axle square to the rim as shown in Figure 8. You put the wood on the tyre or rim so that it is flat and you put the try-square on the wood. You have to move the axle until it is straight with the try-square and your assistant must hold it without moving. Check it several times - its hard to correct!

- 5) Once you have it in position, tack weld the ends of the struts to the axle tube as shown in Figure 9, then weld the struts on properly. Do as much welding as you can without

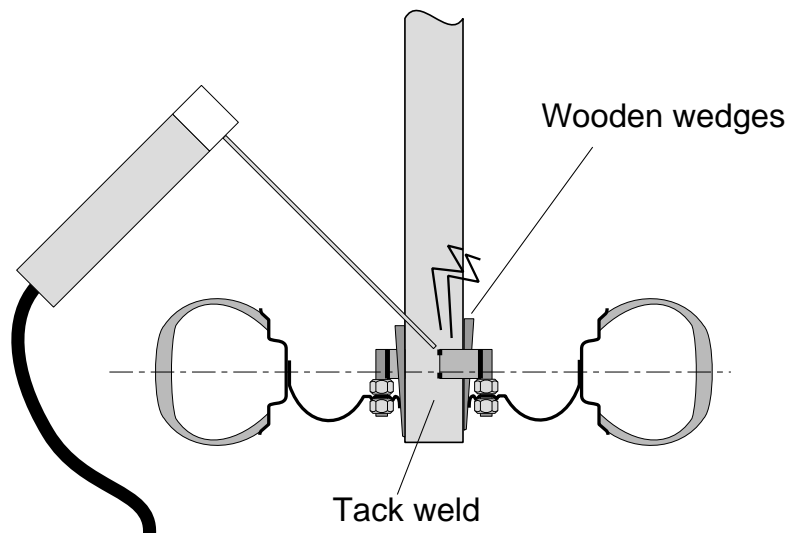


Figure 9: tyre, wheel and axle tube during tack welding stud support struts

taking the axle out of the wheel because the metal changes size as it heats and cools and it may move out of place.

- 6) Next make the bearing tubes from 2" round pipe to the lengths in the cutting list. To mark a line around the pipe to cut it square, wrap a strong piece of paper or thin card around the pipe, get the edge in line and use the edge to guide the felt tip pen or scribe as you mark the line.
- 7) Cut eight 50mm pieces of 8 to 12mm round bar for the bearing tube chocks. Mark the centre of the axle support beam of the cart and put marks on the beam 60mm either side of this. You need to weld the chocks on to the beams so that the bearing tubes just sit nicely in the space between the chocks as shown in Figure 10.
- 8) Fix the axle bearing tubes with loops of 8 to 12mm round bar as shown in Figure 1 and Figure 11. Do not weld the

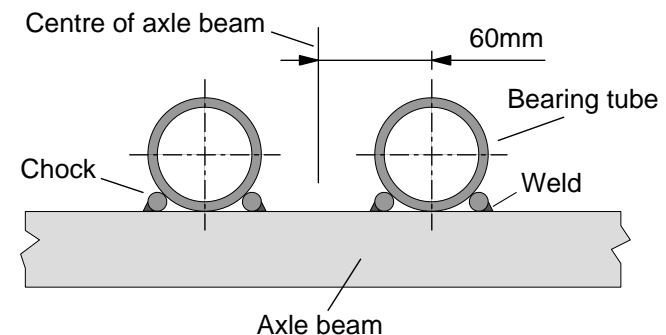


Figure 10: position of bearing tubes and chocks.

bearing tubes directly to the axle support beam. The bearing tubes must be slightly flexible so that they can align themselves with the other bearing on the same axle.

- 9) Make four axial rings of 10 to 12mm square or round bar which just go over the axles. Square bar is better but round will do. You must remember to weld on a tag made of a 15mm length of bar to each ring as shown in the drawings. This makes the rings go round with the axle and stops wear in the wrong places. Put a ring on each axle so the tag goes between two stud support struts.
- 10) Insert an axle into its bearing tubes and push right through until the axial ring touches the bearing tube and then put the second axial ring on.
- 11) Now mark the position of the cross bolt hole. Remember that the nut will have to be turned so do not make the hole too close to the ring - centre about 15mm away is fine. Use

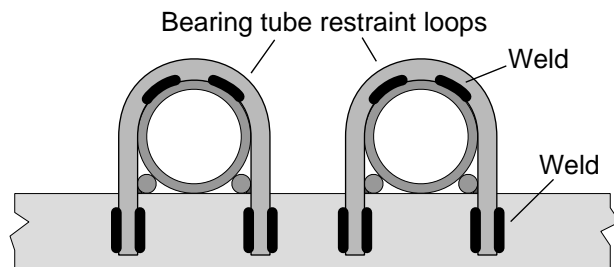


Figure 11: position of bearing tubes and chocks.

the welder to blow a hole through for the bolt. Of course a hole will have to be blown through on the other side of the axle too.

- 12) Cut pieces of PVC tube to lengths shown in the cutting list and either cut along their length or cut around like a spring or screw as shown in Figure 12. Remove axles from bearing tubes, apply lots of grease, fit the PVC bearing pipes and the pie clips and refit axles. Use the pipe clips to stop the PVC pipe coming out of the bearing tubes. Tighten the cross bolts.
- 13) You've finished it!

Other DTU cart developments

The DTU has been working on new designs of wheels, hubs and bearings to bring down their costs and make things more locally manufacturable. It has designs for twin axles with wooden bearings and twin axles with scrap or new ball bearings which do not need any machining. And it has two systems of fixed axle: one with PVC bearings and another



Figure 12: cut PVC bearing tubes like spring to fit axle.

using needle roller bearings which you make yourself. Again for these needle roller bearings no machining is necessary.

Other hub designs using, for example aluminium castings, have been in production in Nigeria and we are trying to reduce or eliminate the machining in these. Also wheel designs in steel sheet, cast aluminium and timber are under development.

The DTU has also been working on a range of cart body types for use with both donkeys and oxen. It has designs for wooden and steel framed types. The wooden types are cheaper in material terms, but the steel framed ones are easier to make because the joints are more straightforward - nevertheless you can make either type of cart in only a few hours, if you are reasonably set up with tools and materials.

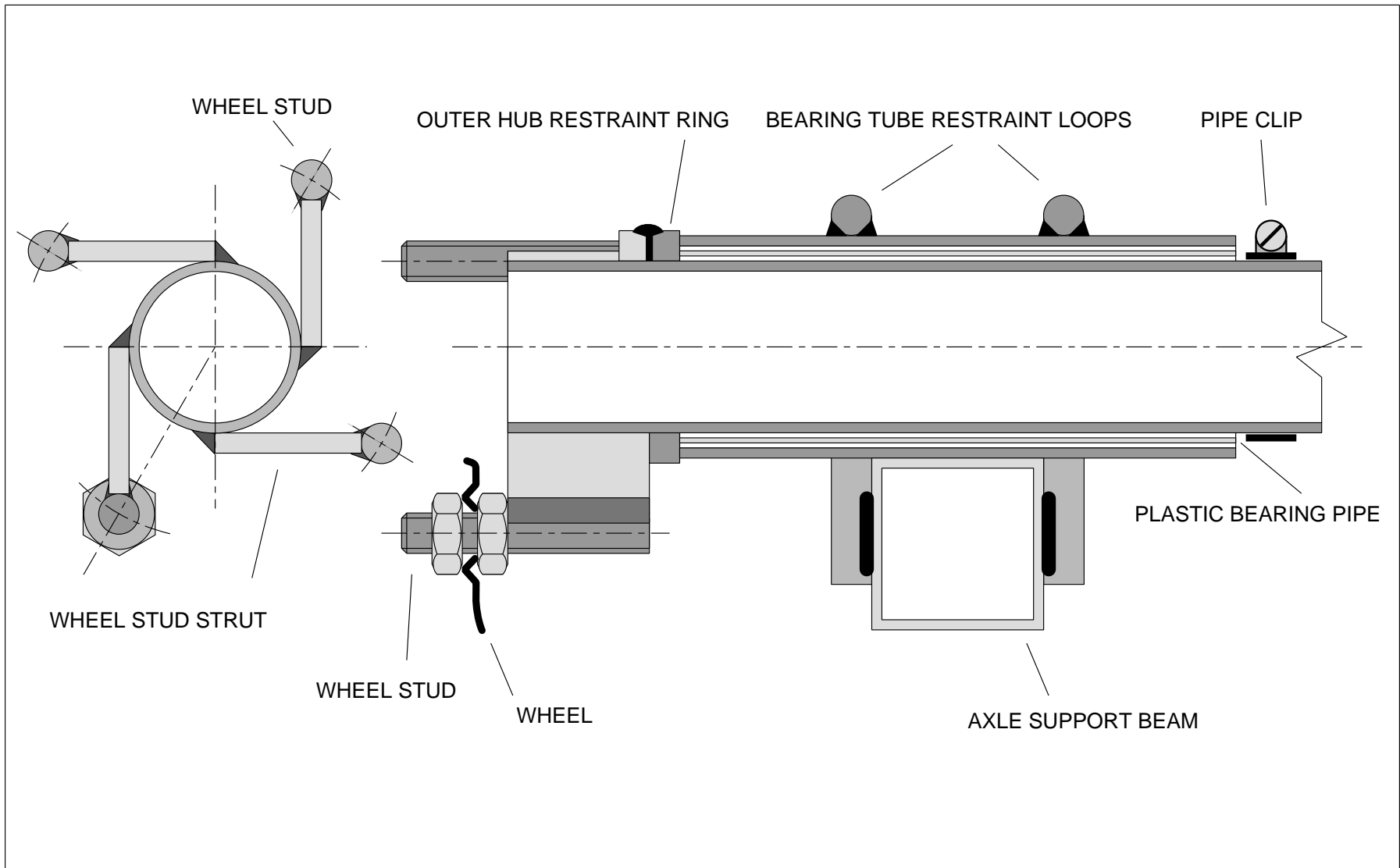
Drawings

You will find four drawings on the next pages, the first two give a general section view of the axle. The third gives a view of the components of the axle itself and the fourth a view of the bearing tube and PVC bearing sleeve.

Acknowledgements

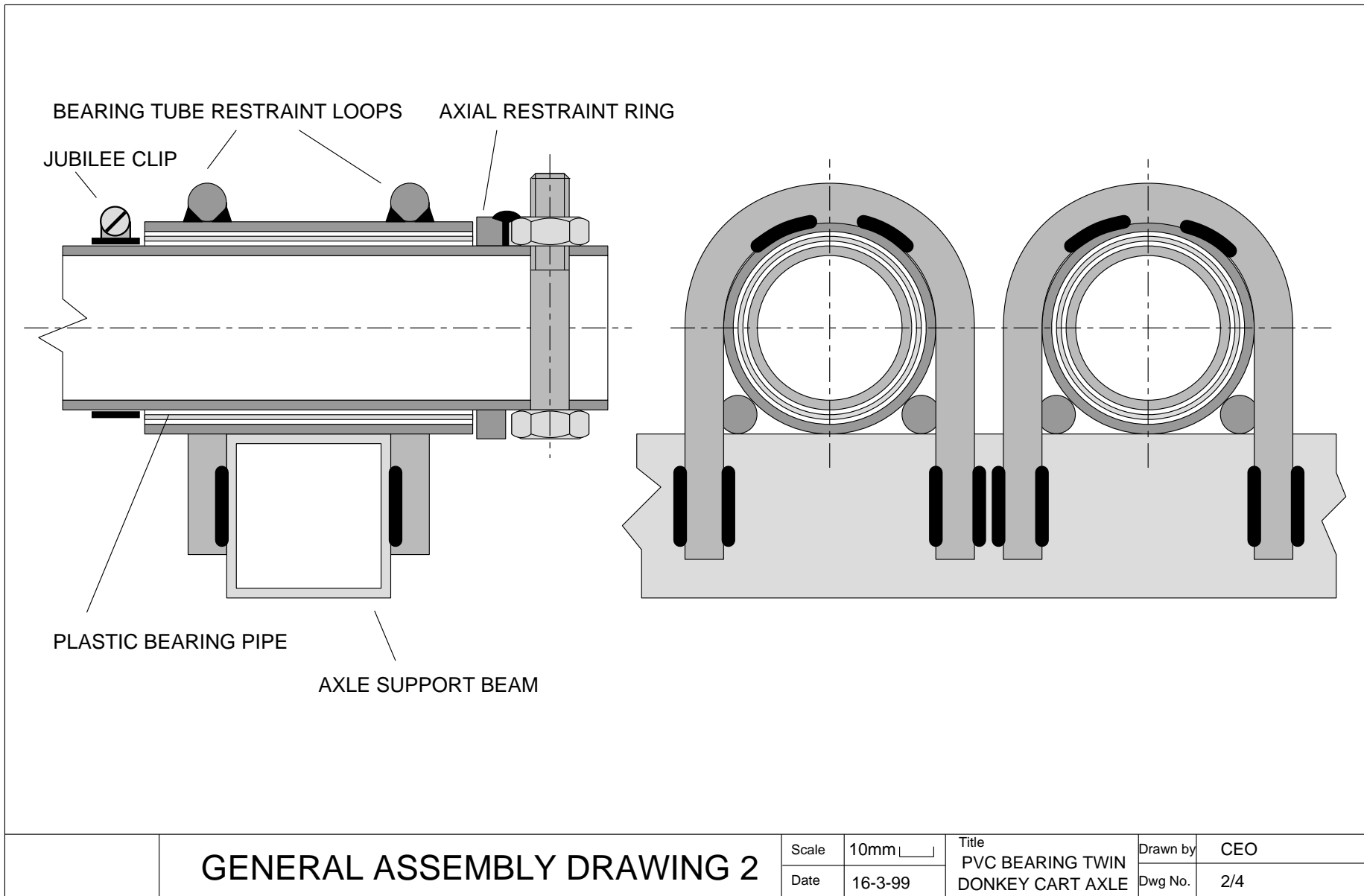
The DTU is grateful to the DFID (British Government) for the financial support necessary to carry out the research and development project under which this product was developed.

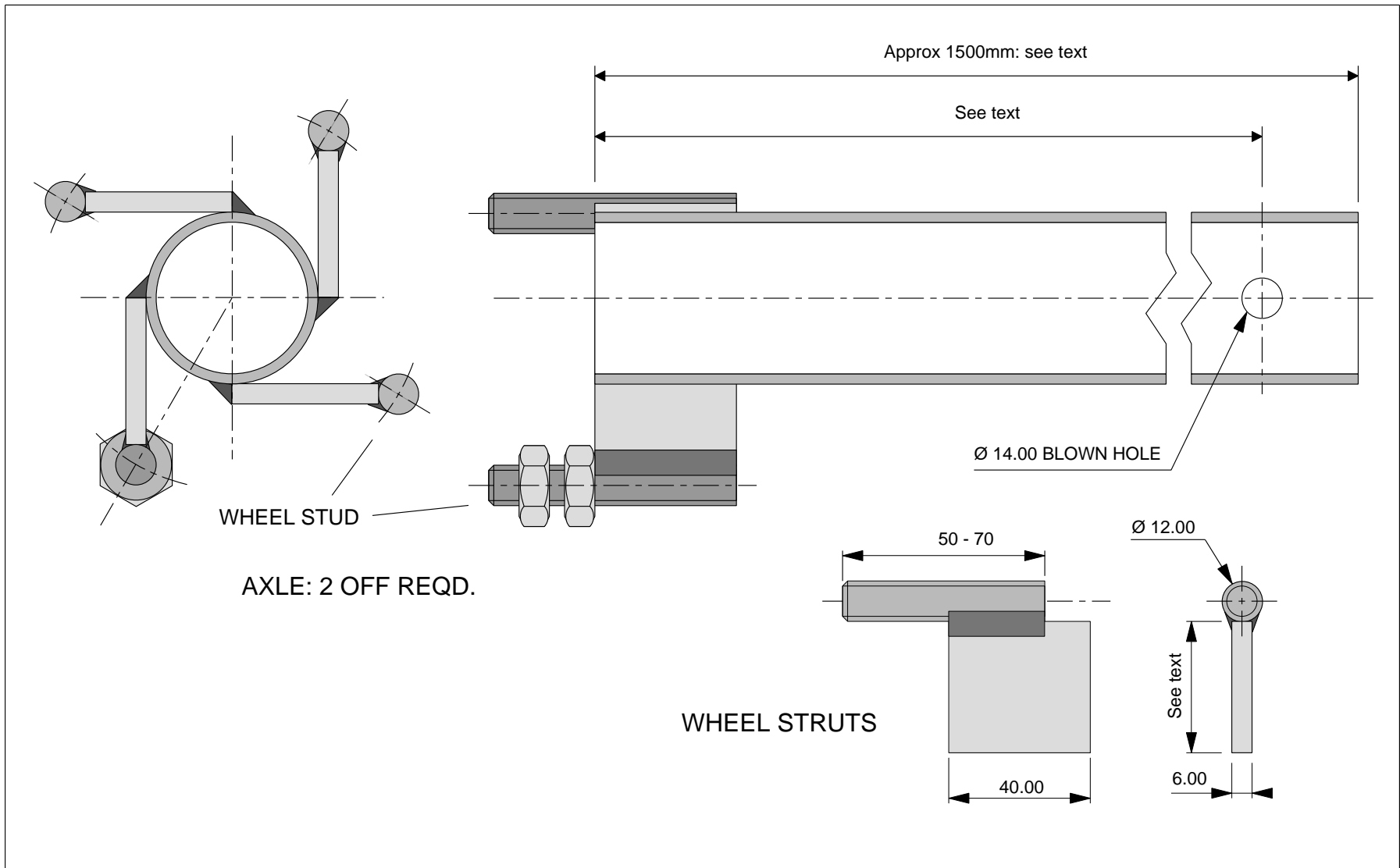
The DTU would also like to thank Dr Pascal Kaumbutho of KENDAT in Kenya and Mr Joseph Mugaga of TOCIDA in Tororo, Uganda for their very considerable help with this project. A large number of other people and organisations have contributed to the success of the project, most notably Mr Anthony Ndungu in Kajiado Kenya, Mr JD Kimani in Kikuyu Kenya and Mr Joseph Gitari in Wanguru Kenya in whose workshops most of the development work of this project was performed. Thanks are due also to Mr Stanley Lameria in Kajiado, Mr Patrick Gitari in Wanguru and Mr Mathew Masai in Machakos for their assistance.



GENERAL ASSEMBLY DRAWING 1

Scale	10mm <input type="checkbox"/>	Title PVC BEARING TWIN DONKEY CART AXLE	Drawn by	CEO
Date	16-3-99		Dwg No.	1/4

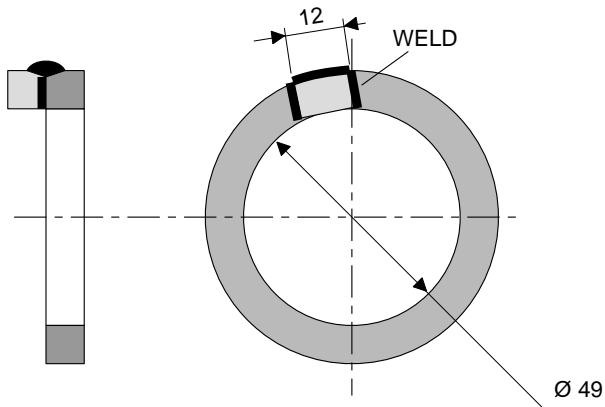
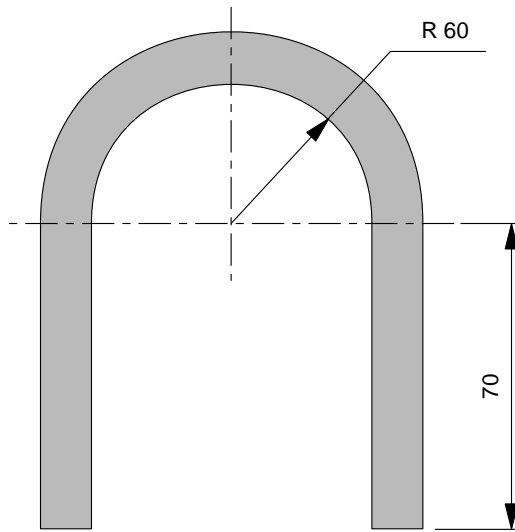




AXLE COMPONENTS

Scale	10mm <input type="checkbox"/>	Title PVC PLAIN BEARING DONKEY CART AXLE	Drawn by	CEO
Date	29-12-96		Dwg No.	3/4

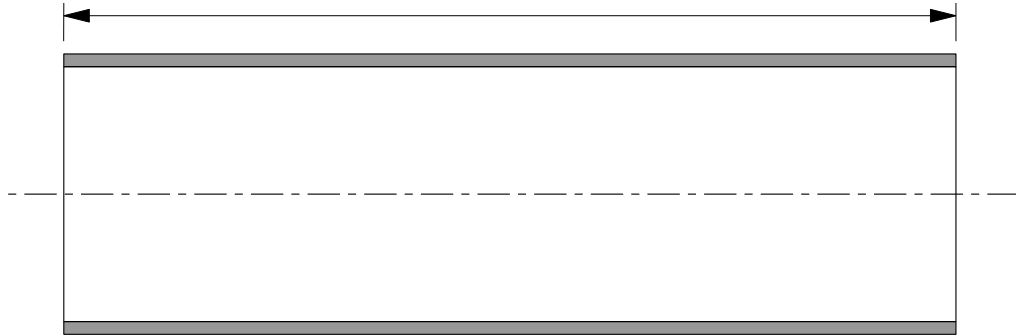
BEARING TUBE SUPPORT LOOPS



AXIAL RESTRAINT RING

HUB TUBE 2" BSP

300: 2 OFF and 100: 2 OFF



PLASTIC BEARING PIPE (SEE TEXT)

300: 2 OFF and 100: 2 OFF



BEARING COMPONENTS

Scale	10mm <input type="checkbox"/>	Title PVC PLAIN BEARING DONKEY CART AXLE	Drawn by	CEO
Date	16-3-99		Dwg No.	4/4