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Performance evaluation of bullock cart on various roads using various loading materials

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■ **ABSTRACT :** This paper covers work carried out at Department of Farm Power and Machinery, Dr. PDKV, Akola. This paper discussed about the performance of the exiting bullock cart on various roads by using the different kind of materials. Drawbar test, track test and haulage test were carried and evaluated the performance of bullock cart. It was found that the pull increased as the laden mass of cart increased on various kinds of roads with the different types of loading materials. The forward speed decreased with continuous work as the laden mass of cart increased on various kinds of roads with the different types of loading materials. The wheel slippage increased as pull increased with laden mass of cart increased for various type of roads. It was observed that the bullock could pull one tonne load at a forward speed of 2 to 3 km/hr with continuous work of 3 hrs. At turning it needs to reduce speed of travel and more attention should give by operator, when cart is fully loaded in order to avoid accident.

■ **KEY WORDS :** Bullock cart, Comfort, Drawbar test, Haulage test, Performance track test

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Animal power is generally affordable and accessible to small land holder, who are responsible for much of the world's food production. The availability of animal power allows women and men to increase their efficiency and reduce their drudgery, compared with manual alternatives. Bullocks are mainly owned by marginal and small farmers for draught purposes. With the modernization of agriculture, the use of mechanical power in agriculture has increased but draught animal power (DAP) continues to be used on Indian farms due to small holdings and hill agriculture (Phaniraja and Panchasara, 2009). In India most of the people use bullock cart for the transportation of agricultural produce from the farm to the respective places. Bullock carts are very popular and cheaper mode of goods transport in rural area. But these bullock carts are manufactured in small scale to moderate scale industry. During manufacturing insufficient use of good material and new design features results in problems such as breakdowns and failures during operations. The existing bullock cart axle designed by the industry uses heavy axle without considering static and dynamic loading conditions which in turn leads to higher factor of safety increasing the overall cost of the axle. Starkey (1988) has discussed the problem of technically excellent products which are too expensive. In this paper an attempt has been made assessment of the characteristics of animal-drawn cart and analysis is made of the advantages and disadvantages of cart in terms of parameters such as load carrying capability, speed of travel, terrain capability at different roads and material; This analysis provides the information necessary to assess

the performance potential bullock cart, and to prepare an overall specification of the most appropriate

■ METHODOLOGY

The bullock cart as shown in Fig A. was evaluated for its performance against different road with loading various load at Department of Farm Power and Machinery, Dr. PDKV, Akola. The detail specifications of bullock cart are presented in Table A.

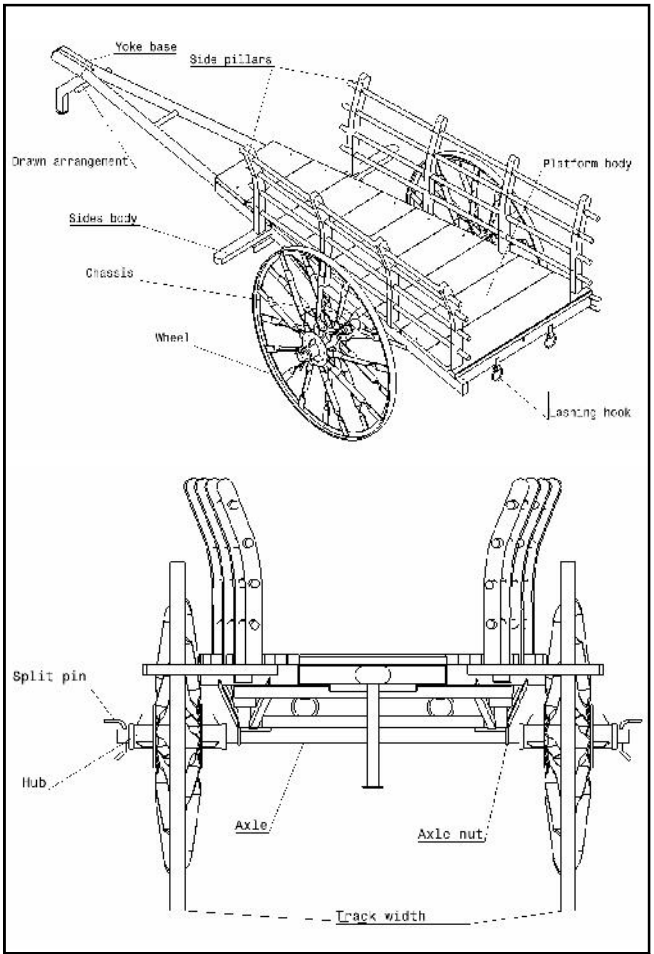

Fig. A : Views of bullock cart

Table A : Specifications of bullock cart

Sr. No.	Particulars	Specifications
1.	**Loading capacity**	
	In mass, kg	1000
	In volume, m^3	1.15
2.	**Frame and platform**	
	Type of platform	Removable
	Overall length of platform, mm	2350
	The height of the cart upto platform, mm	950
	The distance from the front edge of platform to yoke	1310
3.	**Axle**	
	Type of axle shaft,	Round shape
	Type of axle	Light duty
	Axle size, mm	1690 in length and 44 Φ
	Axle nut	It hook MS rod arrangement
4.	**Yoke**	
	The height of yoke from the ground (K)	890
	The horizontal distance between yoke and axle, mm (H)	2575
	The ratio K/H	0.34
5.	**Wheel**	
	Type of wheel	Metallic
	Number and size of wheel, mm	2 and 1150 Φ
	Number and type spokes	18, M.S flat twisted
	Method of fixing to axle	Welded and rivet provided
6.	Ground clearance, mm	550 at the wheel axle
7.	Radius of turning circle, m	1.35
8.	Radius of turning space, m	3.54
9.	**Overall dimensions, mm**	
	Overall length, mm	4030
	Overall width. Mm	1690
	Overall height, mm	1140
10.	Unladen mass (kg)	235.50

Test :

Laboratory test :

It has been carried out for the hardness and chemical composition of the bullock cart axle and observed percentage of carbon, silicon, manganese, sulphur and phosphorus and it is presented in Table B.

Table B : Chemical composition cart axle

Sr.No.	Content	Observed, %
1.	Carbon	0.23
2.	Phosphorus, max	0.023
3.	Silicon	0.09
4.	Manganese	1.14
5.	Sulpher, max	0.021

Drawbar test :

The drawbar test was conducted on bitumen, macadam road of 500 m length. The track was level and without gradient. The degree of surface unevenness in the test track mentioned as per IS: 12161-1987. In this test, measured the pull corresponding to laden mass of cart, forward speed and wheel slippage. The test was carried out with loaded cart in steps of 0.1 tone ranging from 30 per cent desired capacity.

Haulage test :

Haulage test was conducted by hauling recommended pay load on macadam and earthen track. Test conducted is two different types of loading material such as solid material (fertilizer bag) and bulky material (Fodder crop). Three trials each minimum 3 hour for each material as well as road has been conducted as per IS: 12161-1987.

■ RESULTS AND DISCUSSION

Test trials were carried out as per procedure of relevant Indian Standard for the various test conduction. Chemical composition, drawbar test and haulage test was taken for the assessment of the performance of bullock cart. Test trials result are presented in following sequence.

Laboratory test :

In laboratory test hardness and chemical composition of bullock cart axle was analyze and it is presented below.

Hardness :

The surface of hardness of bullock cart axle shaft was observed as 156 HB.

Chemical composition :

Bullock cart axle shaft piece was analyzed for its chemical composition. The results of chemical analysis are given in Table 2.

Drawbar test :

Test track :

The drawbar test was conducted on bitumen, macadam road of 500 m length. The track was level and without gradient. The degree of surface unevenness in the test track mentioned as per IS: 12161-1987. In this test, measured the pull corresponding to laden mass of cart, forward speed and wheel slippage. In testing procedure loaded the cart was done in steps of 0.1 tone ranging from 30 per cent desired capacity.

The effect of laden mass of cart, forward speed and wheel slippage on pull is presented in Fig. 1 to Fig. 12. The details measurement of animals used for

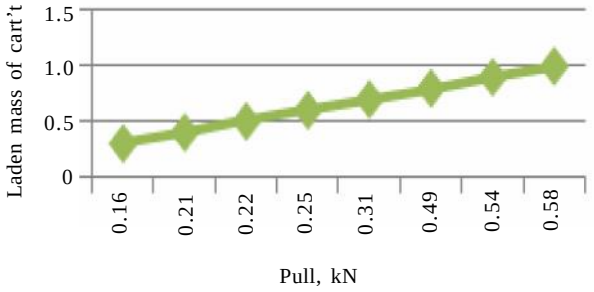

Fig. 1 : Laden mass of cart as a function of pull for solid material at bitumen road

Table 1 : Performance result of bullock cart haulage test on bitumen road

Sr. No.	Haulage test	Solid material haulage on recommended pay load			
	Parameters / trials	I	II	III	Remark
1.	Duration of test ,h	3.20	3.64	3.05	As per Indian Standard each test taken of minimum 3 h.
2.	Laden mass of the cart, t	1	1	1	---
3.	Operator weight, kg	74	74	74	---
4.	Travel speed, km/h	2.42	2.38	2.40	Easy to pool by utilize bullock pair
5.	Turning ability	Easy	Easy	Easy	Need to reduce speed of travel and more attention of the operator while turning.
6.	Stability of cart (on level and slope of 6 to 8 %)	Stable	Stable	Stable	Undulation on the off roads disturbs the stability.
7.	Comfort to pulling animals	Comfort	Comfort	Comfort	More speed of operation reduces the comfort
8.	Comport to operator	Comfort	Comfort	Comfort	Satisfactory seating space to operate

conducting test are as in Table 5.

It is evident from these Fig. 1, 4, 7 and 10 pull increased as the laden mass of cart increased for all type of road at all type of laden material in bullock cart.

From the Fig. 2, 5, 8 and 11 it is clear that forward speed decreased as the laden mass of cart increased for all type of roads at all type of laden material in bullock cart.

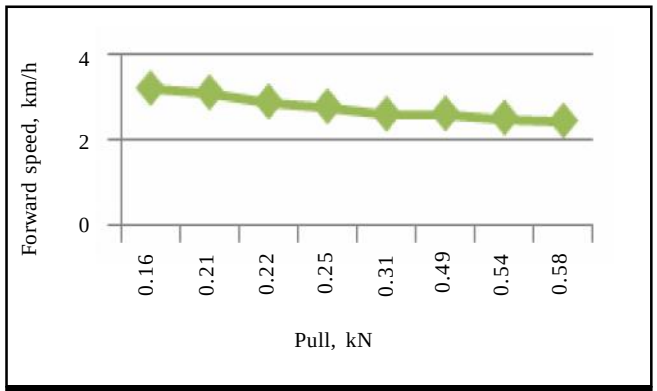

Fig. 2 : Forward speed as a function of pull for solid material at bitumen road

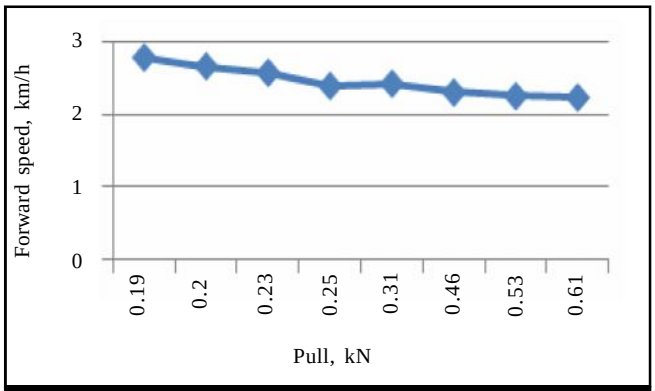

Fig. 5 : Forward speed as a function of pull for solid material at macadam road

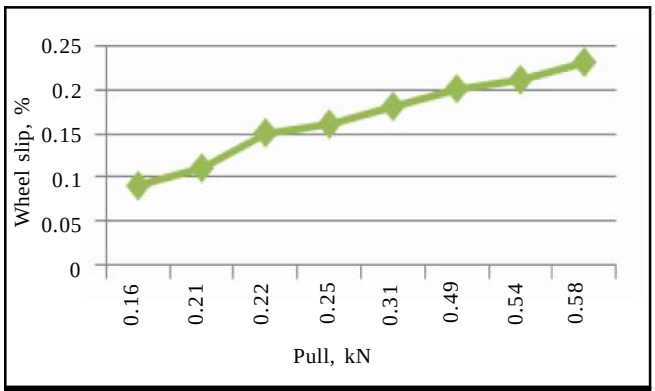

Fig. 3 : Wheel slippage as a function of pull for solid material at bitumen road

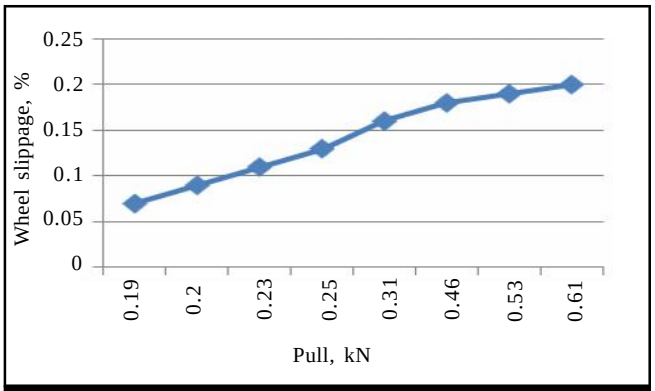

Fig. 6 : Wheel slippage as a function of pull for solid material at macadam road

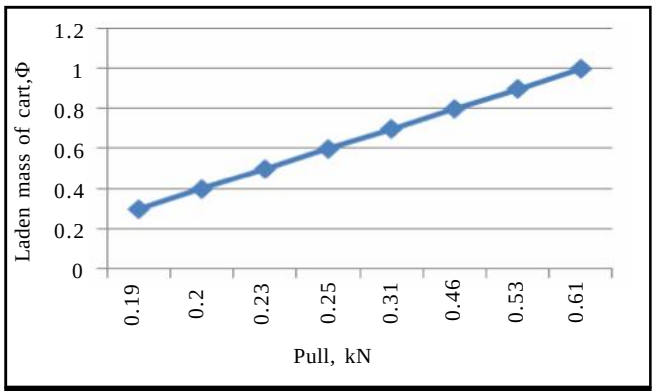

Fig. 4 : Laden mass of cart as a function of pull for solid material at macadam road

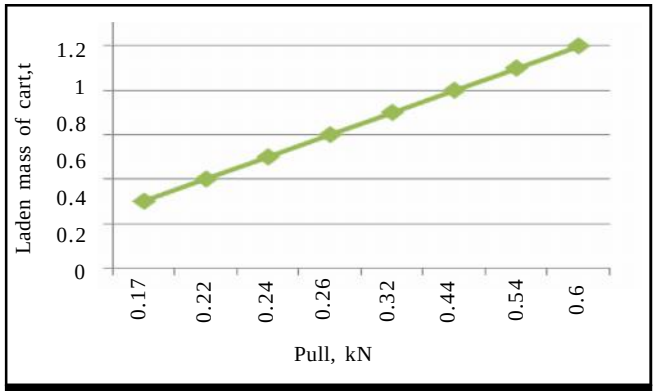

Fig. 7 : Laden mass of cart as a function of pull for bulky material at bitumen road

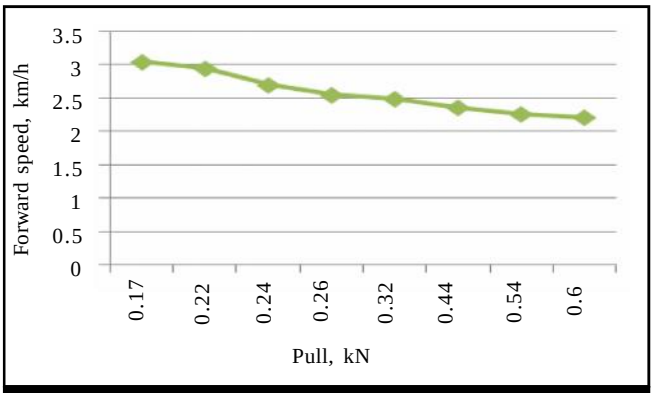

Fig. 8 : Forward speed as a function of pull for bulky material at bitumen road

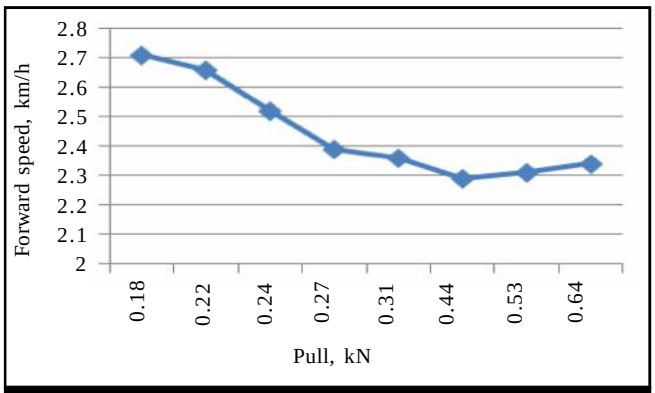

Fig. 11 : Forward speed as a function of pull for bulky material at bitumen road

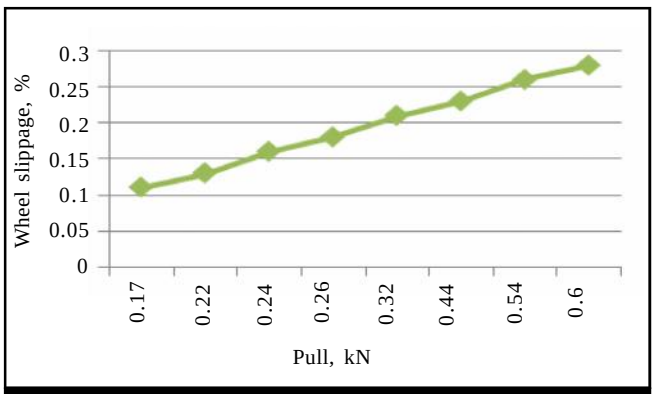

Fig. 9 : Wheel slippage as a function of pull for bulky material at bitumen road

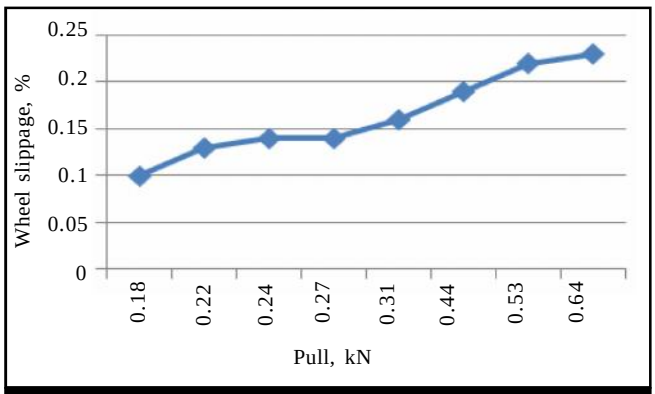

Fig. 12 : Wheel slippage as a function of pull for bulky material at bitumen road

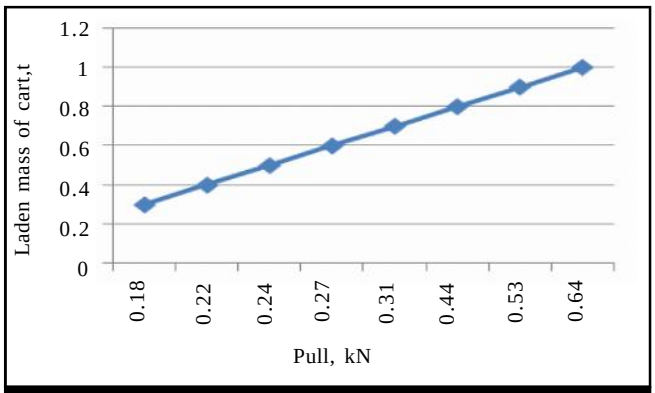

Fig. 10 : Laden mass of cart as a function of pull for bulky material at macadam road

It indicates that these Fig. 3, 6, 9 and 12, wheel slippage increased as pull increased with laden mass of cart increased for all type of roads at all type of laden material in bullock cart Anonymous (2013); Behera *et al.* (2006a and b).

Haulage test :

Haulage test was conducted by hauling recommended pay load on macadam and earthen track. Test conducted in two different types of loading material such as solid material (fertilizer bag) and bulky material (Fodder crop). Three trials each minimum 3 hour for each material as well as road has been conducted as per IS: 12161-1987. Details test results are presented in Tables 1- 4.

Conclusion :

From the above test trials following conclusions could be drawn :

The pull increased as the laden mass of cart increased and forward speed decreased as the laden mass of cart increased on various kinds of road with

Table 2 : Performance result of bullock cart haulage test on bitumen road

Sr. No.	Haulage test	Bulky material haulage on recommended pay load			
	Parameters/trials	II	II	III	Remark
1.	Duration of test ,h	3.33	3.24	3.42	As per Indian standard each test taken of minimum 3 h.
2.	Laden mass of the cart, t	1	1	1	--
3.	Operator weight, kg	74	74	74	--
4.	Travel speed, km/h	2.20	2.94	2.13	Easy to pull by utilize bullock pair
5.	Turning ability	Slightly uneasiness	Slightly uneasiness	Slightly uneasiness	Need to reduce speed of travel and more attention of the operator.
6.	Stability of cart (on level and slope of 6 to 8 %)	Stable	Stable	Stable	Wind speed, undulation on the off roads makes unstable
7.	Comfort to pulling animals	Comfort	Comfort	Comfort	More speed of operation reduces the comfort
8.	Comport to operator	Slightly discomfort	Slightly discomfort	Slightly discomfort	Some extend of seating space of operators reduced

Table 3 : Performance result of bullock cart haulage test on earthen road

Sr. No.	Haulage test	Solid material haulage on recommended pay load			
	Parameters/trials	I	II	III	Remark
1.	Duration of test ,h	3.18	3.04	3.29	As per Indian standard each test taken of minimum 3 h.
2.	Laden mass of the cart, t	1	1	1	---
3.	Operator weight, kg	74	74	74	---
4.	Travel speed, km/h	2.21	2.22	2.17	Easy to pull by bullock pair
5.	Turning ability	Easy	Easy	Easy	Need to reduce speed of travel and more attention of the operator.
6.	Stability of cart (on level and slope of 6 to 8 %)	Stable	Stable	Stable	Undulation on the off roads makes of unstable.
7.	Comfort to pulling animals	Comfort	Comfort	Comfort	More speed of operation reduces the comfort
8.	Comport to operator	Comfort	Comfort	Comfort	Satisfactory seating space to operate

Table 4 : Performance result of bullock cart haulage test on earthen road

Sr. No.	Haulage test	Bulky material haulage on recommended pay load			
	Parameters/trials	II	II	III	Remark
1.	Duration of test ,h	3.50	3.18	3.34	As per Indian Standard each test taken of minimum 3 h.
2.	Laden mass of the cart, t	1	1	1	---
3.	Operator weight, kg	74	74	74	--
4.	Travel speed, km/h	2.20	2.23	2.22	Easy to pull by bullock pair
5.	Turning ability	Slightly uneasiness	Slightly uneasiness	Slightly uneasiness	Need to reduce speed of travel and more attention of the operator.
6.	Stability of cart (on level and slope of 6 to 8 %)	Stable	Stable	Stable	Wind speed, undulation on the off roads makes unstable
7.	Comfort to pulling animals	Comfort	Comfort	Comfort	More speed of operation reduces the comfort
8.	Comport to operator	Slightly discomfort	Slightly discomfort	Slightly discomfort	Some extend of seating space of operators reduced

Table 5 : Measurements of bullocks used for test

Sr. No.	Particulars	Measurements of bullocks	
		I	II
1.	Number	Pair	
2.	Breed	Gaolao	Gaolao
3.	Whether fitted with shoe	Not fitted shoe	Not fitted shoe
4.	Height, cm	130	126
5.	Paunch girth, cm	60	57
6.	Chest girth, cm	65	63
7.	Body depth, cm	50	48
8.	Mass, kg	331	312

different kinds of loading materials.

The wheel slippage increased as pull increased with laden mass of cart increased on various kinds of road with different kinds of loading materials.

One tonne bullock cart loaded can easy to pull by bullock pair at as speed 2 to 3 km/h with comfort pulling of a continuous work of 3 h.

At turning it is needs to reduce speed of travel and more attention should give by operator.

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