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Metal Road Ring for Tractor Cage Wheels to Prevent Road Damage

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ABSTRACT

Puddling with cage wheels is more common in India for easy and quick puddling with tractors by replacing the normal wheels with cage wheels. For attending puddling operations, the tractor cage wheel has to be brought to the field. Repeated cage wheel movements on the village roads in general and tar roads in particular, make small to large depth of indents. The average depth of indent is varying from 5mm to 18mm on earthen road, 6mm to 17mm on gravel road and 0.5mm to 6mm on bitumen road. With increase in load on tractor, the depth may further deepen and finally makes the roads unusable. In Andhra Pradesh, every year 13,000km are damaged by tractor cage wheels. The cost of restoration of damage caused by tractor cage wheels in the state is about Rs. 30 core every year on R& B. To avoid this unnecessary expenditure, a stable metal road ring that can be fixed on the surface of the cage wheel easily, which costs less and more useful is fabricated at College of Agricultural Engineering, Bapatla and was tested on different roads and at different speeds. The metal road ring developed is found to reduce the depth of indent on the order of 77% to 88%in various road conditions.

Key words : Cage wheels, Depth of indent,Metal road ring.

Major portion of paddy production (nearly 70%) is under irrigated conditions by transplanting seedlings in India. For transplanting paddy, soil is drenched in 5 cm standing water and then puddled with animal drawn puddler or tractor drawn puddler or cage wheels attached to tractor. A cage wheel (Sahay 1990) is a wheel or a attachment with a spaced cross bars for improving traction of tractor in wet lands. Because of easiness of operation and better soil conditions, cage wheel puddling is more common. In light and medium soils, half cage wheels are fitted to back tyres and for medium and heavy soils, full cage wheels are used in place of pneumatic tyres. Saloke et al. (1989) observed that the cage wheels are easy to fabricate and maintain, Traction is more, sinkage and blocking in deep soils is less. They also reported that steering forces are more, cage wheels damage roads by their cutting edges. The full cage wheel puddling is effective in mixing fertilizers, in suppressing weed and bacterial grown in reducing percolation losses and creating suitable physical conditions of soil.

For attending these puddling operations, the tractor cage wheel has to be brought to the field. Repeated cage wheel movements from home to field, field to field and field to home on the village roads and finally makes the roads unusable. The average depth of indent is varying from 5mm to 18mm on earthen road, 6mm to 17mm on gravel road and 0.5mm to 6mm on bitumen road. With increase in load on tractor, the depth may further deepened and finally makes the roads unusable.

In Andhra Pradesh total length of roads is about 1,21,125.91 km (R& B year dairy 2003), of which 39000 km are bitumen roads. Out of 39,000km of bitumen roads, every year 13,000Km (Rajeswar Reddy 1998) are damaged by tractor cage wheels. The cost of laying a bitumen road is nearly Rs. 15 lakhs/km. Even for laying bitumen surface on already existing road costs about Rs. 3.5 lakhs/km. The cost of restoration of damage caused by tractor cage wheels in the state is about Rs. 30 core every year on R& B. To avoid this unnecessary expenditure, Rajeswar Reddy (1998) developed a technique for encasing cage wheels. A steel plate of 46mm×6mm mild plate is bent to form a half circle. Six clamps with holes are welded at intervals. As it is made 6mm thick, increased load may cause damage to ring and also wear and tear is more. Hence, there is a need to develop a stable road ring which costs less and more useful to avoid unnecessary expenditure on government.

MATERIAL AND METHODS

The cage wheel used for experimentation has 3 metal rings. The diameter of middle ring is 1270mm and two outer rings are 1120mm. Width of cage wheel is 900mm.

Fabrication of metal road ring

The outer diameter of cage wheel is taken as inner diameter of metal ring. A 75×12mm mild steel

Table 1. Depth of indent on bitumen road by the cage wheels while operating in different speeds and attached with various implements

Implement attached	Weight, Kg	Average depth of indent, mm			Average,mm
		Gear-1 (6.5 kmph)	Gear-2 (8 kmph)	Gear-3 (12 kmph)	
Tractor with cage wheels	1810	2.30	2.00	1.83	2.04
Tractor with cage wheels + cultivator	2035	3.66	3.33	3.00	3.33
Tractor with cage wheels + Rotovator	2060	4.30	3.33	3.16	3.59
Tractor with cage + Disc harrow	2075	4.80	3.40	3.20	3.80
Tractor with cage wheels + cultivator + 100 kg weight	2135	5.30	4.80	4.50	4.86
	Average	4.07	3.37	3.13	

Table 2. Depth of indent on bitumen road by the cage wheels with metal road ring while operating in different speeds and attached with various implements

Implement attached	Weight, Kg	Average depth of indent, mm			Average,mm
		Gear-1 (8 kmph)	Gear-2 (10 kmph)	Gear-3 (14 kmph)	
Tractor with cage wheels	1890	0.40	0.40	0.35	0.38
Tractor with cage wheels + cultivator	2115	0.45	0.40	0.40	0.42
Tractor with cage wheels + Rotovator	2140	0.45	0.50	0.50	0.48
Tractor with cage + Disc harrow	2155	0.55	0.50	0.50	0.52
Tractor with cage wheels + cultivator + 100 kg weight	2215	0.60	0.55	0.50	0.55
	Average	0.49	0.47	0.45	

plate(Figure1) of length 2000mm is bent into an half circle of diameter 1270mm. Ring is made into two halves namely bottom ring and top ring are joined to form a full ring . Two 10×10mm square rods of 1970mm are taken and welded on ring surface so that cage wheel edge will not move sideways. Four eyes of 20mm diameta and 25mm length are welded to the ends of half ring are joined with bolts and nuts of 15mm diameter.

Fabrication of a depth gauge stand

The depth of indent is measured with vernier calipers (L.C=0.02mm). A stand is fabricated to keep vernier calipers in erect position to take depth of indent. Nuts are welded to legs a bolt is made to move in the nut resulting in adjustment of height. A spirit level is attached to check level of stand.

Experiments are carried out on three different roads (Bitumen (Tar) road, Gravel road and Earthen road) and full cage wheels with different implements

Fig 1 . Metal road ring for test cage wheels

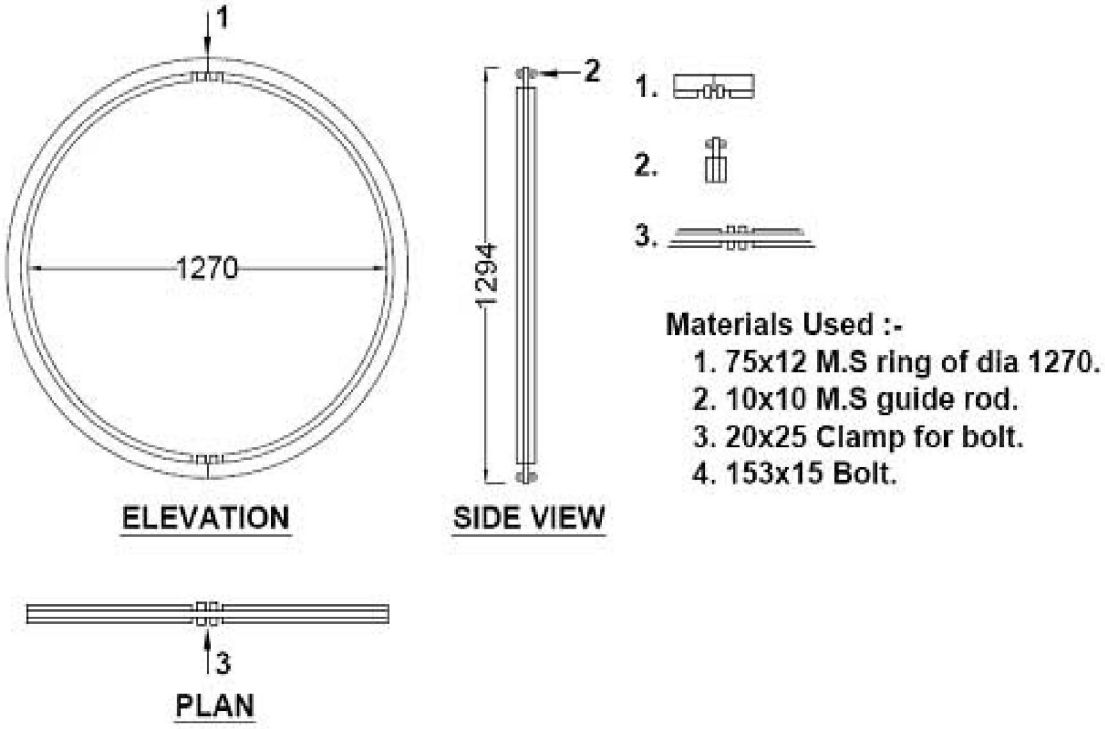


Fig 2. Variation of depth of indent on bitumen road at different gear positions with different implements with and without road ring

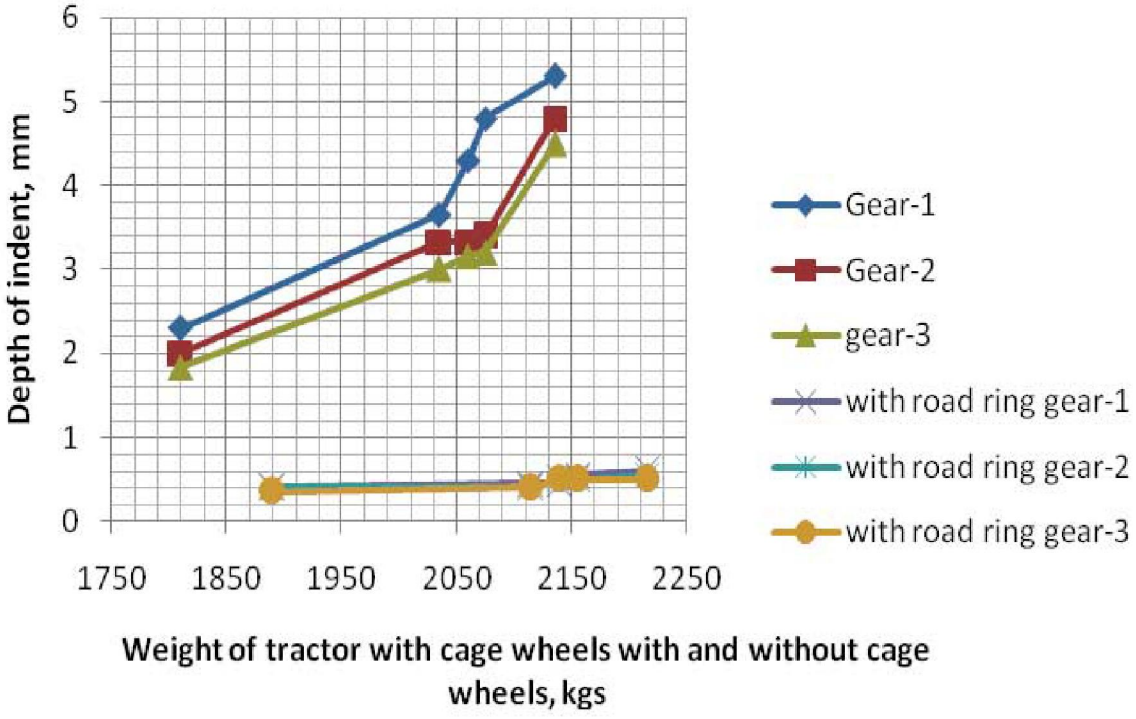


Table 3. Percentage reduction of depth of indent on different roads and attached with different implements

Implement	Bitumen road			Gravel road			Earthen road		
	Without road ring, mm	With road ring, mm	Percentage reduction	Without road ring, mm	With road ring, mm	Percentage reduction	Without road ring, mm	With road ring, mm	Percentage reduction
Tractor with cage wheels	2.04	0.38	81.4	11.53	1.50	87	9.37	2.00	78.6
Tractor with cage wheels + cultivator	3.33	0.42	87.4	12.33	2.00	83.7	12.57	2.00	84.1
Tractor with cage wheels + Rotovator	3.59	0.48	86.6	12.16	2.00	83.5	13.83	2.67	80.6
Tractor with cage + Disc harrow	3.80	0.52	86.3	13.27	2.00	84.9	14.41	2.67	81.5
Tractor with cage wheels + cultivator + 100 kg weight	4.86	0.55	88.6	15.27	2.67	82.5	15.50	3.00	80.6

Table 4. Percentage reduction of depth of indent on different roads and attached with different speeds

Gear Position	Bitumen road			Gravel road			Earthen road		
	Without road ring, mm	With road ring, mm	Percentage reduction	Without road ring, mm	With road ring, mm	Percentage reduction	Without road ring, mm	With road ring, mm	Percentage reduction
Gear -1	4.07	0.48	88.2	14.62	2.10	85.6	15.34	2.60	83.1
Gear -2	3.37	0.47	86.1	13.18	2.10	84.1	13.20	2.40	81.8
Gear -3	3.13	0.46	85.3	10.93	1.90	82.6	10.86	2.40	77.9

commonly used for puddling (Cultivator, Rotovator and Disc harrow). Initially each road is marked with chalk at every 10m distance from starting point up to 270 m distance. The tractor is at first gear in first 90m distance, in second gear in next 90m distance and in third gear in last 90m distance. The measurements are taken in the middle 30 m of 90m distance. 3 readings of depth of indent are taken at each 10m distance in the middle 30m distance of each 90m distance with different speeds. The same procedure is followed for all treatments.

Measurement of depth of indent on different roads

Depth of indent is measured at each 10m distance in the middle 30m distance of each 90m distance. The depth gauge stand is placed over the surface where the depth is going to be measured. The stand is brought to level by rotating height adjusting bolts in the leg nut until air bubble of sprit level comes to middle. After leveling, the reading on both sides of the indent is taken as D_2, D_3. After instrument is moved exactly over the indent and scale reading is noted as D_1.

Depth of indent = D1-(D2+D3)/2

Measurement of speed

The time taken to travel 30m distance is noted down with stop watch and speed is calculated as

Speed(Kmph) = 30×3600/T×1000 = 108/T.

Where T= Time in seconds.

Fig 3. Percentage reduction in depth of indent on different roads with different implements

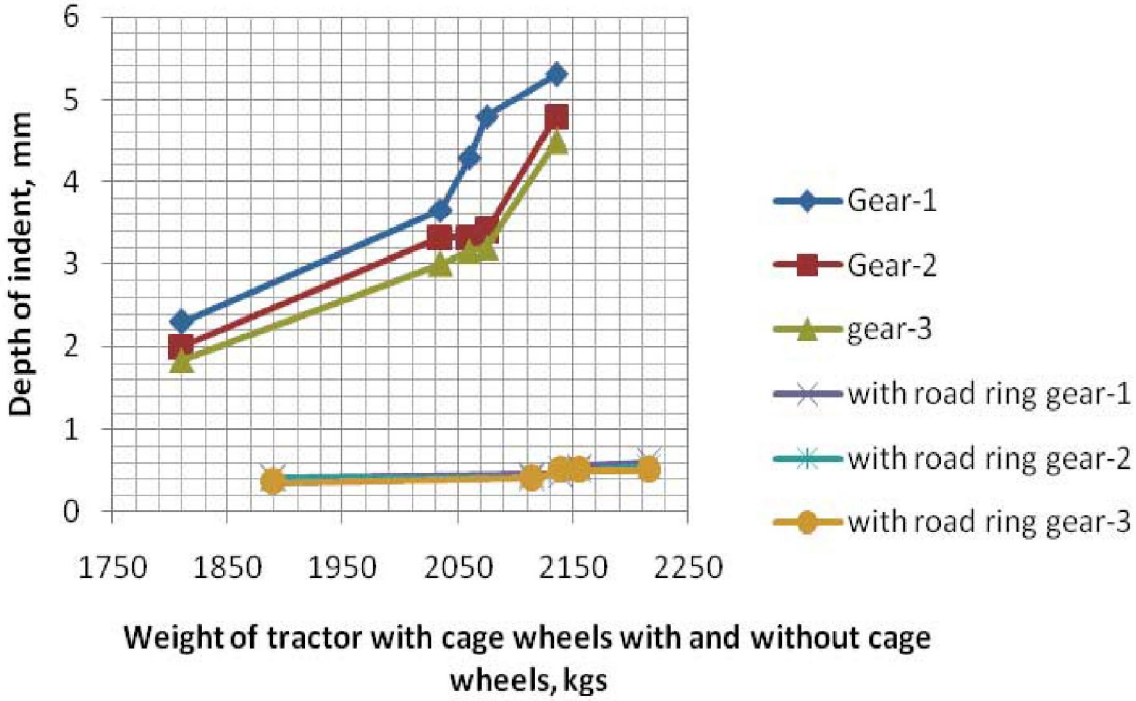
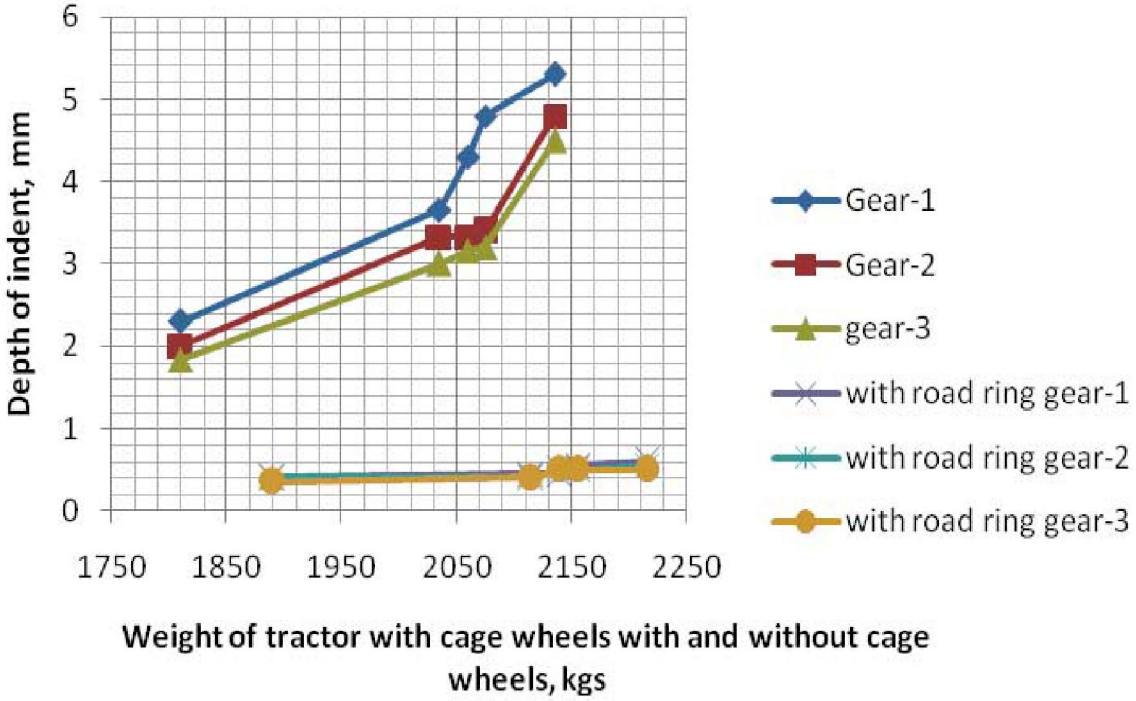


Fig 4. Percentage reduction in depth of indent on different roads with different speeds



RESULTS AND DISCUSSION

Data collected on depth of indent on three roads (Bitumen road, Gravel road and earthen road) at various speeds and loads with and without road ring has been systematically analyzed. As an example the results on Bitumen road are shown as below.

Tractor running on bitumen road with cage wheels and different implements without metal road ring

The average depth of indent on bitumen road(Table-1) is 2.3 mm in gear-1, 2mm in gear-2 and 1.83 mm in gear-3. This indicates that the increase in speed reduced the depth of indent. The same trend is observed in all other treatments also. The average depth of indent is 2.04 mm when the tractor is moved on cage heels only. This has been increased to 3.33 mm, 3.59mm, 3.8mm and 4.86mm when cultivator, rotovator, disc harrow and cultivator+ 2 fertilizer bags (50 Kg each) respectively attached to tractor. In the same manner, the average depth of indent is 4.072mm, 3.37 mm and 3.13mm on gear-1, gear-2 and gear-3 respectively.

Tractor running on bitumen road with cage wheels and different implements with metal road ring

The average depth of indent on bitumen road (Table.2) is 0.4 mm in gear-1, 0.4 mm in gear-2 and 0.35 mm in gear-3. This indicates that the increase in speed reduced the depth of indent. The same trend is observed in all other treatments also. The average depth of indent is 0.38 mm when the tractor is moved n cage heels attached with road ring. This has been increased to 0.42 mm, 0.48mm, 0.52mm and 0.55mm when cultivator, rotovator, disc harrow and cultivator+ 2 fertilizer bags (50 Kg each) respectively attached to tractor. In the same manner, the average depth of indent is 0.49mm, 0.47 mm and 0.45mm on gear-1, gear-2 and gear-3 respectively.

From the above results it shows that(Fig 2) with 100 kg increase in weight on tractor increases depth of indent to 0.86 mm. For every1 kmph increase in speed decreases the average depth of indent as 0.167mm. This shows that with 100 kg increase in weight on tractor increases depth of indent to 0.06 mm. For every1 kmph increase in speed decreases the average depth of indent as 0.0064mm.

Comparison of depth of indent with out and with road ring attached to cage wheels:

The average depth (Table 3) of indent is 2.04 mm, when tractor moved on bitumen road with cage wheels. It was reduced to 0.38mm, when metal road ring attached to cage wheels. The reduction in indent is 81.4%. It was shown graphically (Fig.3) The same was 87% and 78.6% on gravel road and earthen road. The percent reductions are 87.4%, 86.6%, 86.3% and 88.6% in other treatments on bitumen road. In same way one gravel road 83.7%, 83.5%, 84.9% and 82.5% and on earthen road84.1%, 80.6%, 81.5% and 80.6% are observed. From the results it has been concluded that with every 100 kg reduction in weight, the depth of indent reduced to 83.8%. The cage wheel attached with tractor, the reduction in indent (Table 4 & Fig 4) in gear-1 is 88.2%, 85.6% and 83.1% respectively on bitumen, gravel and earthen road. In gear-2 same was 86.1%, 84.1% and 81.8%. In gear-3 it was 85.3%, 82.6% & 77.9%. From the results obtained from the study, it can be concluded that the road rings if standardized and fabricated for ready usage on the surface of the cage wheels will prevent not only the damage of the roads but also reduce time and drudgery involved in removing the cage wheels many times during puddling operation by the farmers.

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