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## Modeling of Contact Length for Radial-Ply Tire Based on Section Width, Overall Unloaded Diameter, Inflation Pressure, Vertical Load and Rotational Speed

Babak Jaberinasab, Majid Rashidi and Iraj Ranjbar

### Department of Agricultural Machinery, Takestan Branch, Islamic Azad University, Takestan, Iran

**Abstract:** This study was conducted to model contact length (L) of radial-ply tire based on section width (b), overall unloaded diameter (d), inflation pressure (P), vertical load (W) and rotational speed (N). For this reason, contact length of three radial-ply tires with different section width and overall unloaded diameter were measured at three levels of inflation pressure, four levels of vertical load and six levels of rotational speed. In order to model contact length based on section width, overall unloaded diameter, inflation pressure and vertical load, a five-variable linear regression model was suggested and all the data were subjected to regression analysis. The statistical results of study indicated that the five-variable linear regression model L = 559.7 - 0.059 b - 0.651 d - 2.930 P + 0.320 W - 0.009 N with R<sup>2</sup> = 0.9715 may be suggested to predict contact length of radial-ply tire based on section width, overall unloaded diameter, inflation pressure, vertical load and rotational speed for a limited range of radial-ply tire sizes.

Key words: Radial-ply tire • Contact length • Section width • Overall unloaded diameter • Inflation pressure • Vertical load • Rotational speed • Modeling

### INTRODUCTION

A flexible tire has a smaller contact area on hard surface than it dose on soft ground. A rule of thumb which can be used for estimation of tire contact area is shown by equation 1 [1]:

 $A = bL \tag{1}$ 

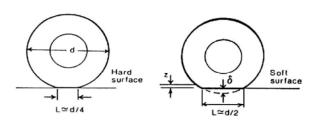
McKyes [1] gave an approximate method for

estimating contact length of tire on hard and soft surfaces (Fig. 1) as given below in equations 2 and 3, respectively:

Where:

A =	Contact area	a of tire	$(m^2)$
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- b = Section width of tire (m)
- L = Contact length of tire (m)



Fg. 1: Contact lengths of tires on hard and soft surfaces, adapted from McKyes [1]

$$L = \frac{d}{4}$$
 (On a hard surface) (2)

$$L = \frac{d}{2} \text{ (On a soft surface)} \tag{3}$$

Where:

d = Overall unloaded diameter of tire (m)

**Corresponding Author:** Dr. Majid Rashidi, Ph.D., Department of Agricultural Machinery, Takestan Branch, Islamic Azad University, Takestan, Iran.

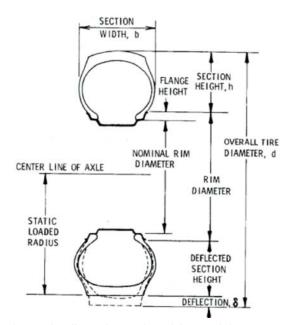


Fig. 2: Tire dimensions, adapted from Brixius [4]

Moreover, Wong [2] and Bekker [3] gave an approximate method for calculating contact length of tire as given below in equation 4:

$$L = 2(d\delta - \delta^2)^{0.5} \tag{4}$$

Where:

 $\delta$  = Deflection of tire (m)

Tire contact length is a key parameter and many equations have been developed based on tire contact length to evaluate the tractive performance of radial-ply and bias-ply tires operating in cohesive-frictional soils. Gross traction, motion resistance, net traction and tractive efficiency are predicted as a function of soil strength, tire load, tire slip, tire size, tire deflection and tire contact length [4]. Fig. 2 shows the tire dimensions (b, d and  $\delta$ ) used. The tire dimensions can be obtained from tire data book or by measuring the tire. The section width (b) is the first number in a tire size designation. The overall unloaded diameter (d) can be obtained from the tire data handbooks available from off-road tire manufacturers. The tire deflection ( $\delta$ ) on a hard surface is equal to d/2 minus the measured static loaded radius. The static loaded radius for the tire's rated load and inflation pressure is standard tire data from the tire data handbooks. It can also be obtained by measuring the tire [4, 5].

As contact length for a given tire size, inflation pressure, vertical load and rotational speed may significantly be different between radial-ply and bias-ply tires, this study was conducted to model contact length (L) of radial-ply tire based on section width (b), overall unloaded diameter (d), inflation pressure (P), vertical load (W) and rotational speed (N) using a linear regression model.

### MATERIALS AND METHODS

**Tire Contact Length Test Apparatus:** A tire contact length test apparatus was designed and constructed to measure contact length of tires with different sizes at diverse levels of inflation pressure, vertical load and rotational speed (Fig. 3).

**Experimental Procedure:** For this purpose, contact length of three radial-ply tires with different section width and overall unloaded diameter were measured at three levels of inflation pressure, four levels of vertical load and six levels of rotational speed. The section width and overall unloaded diameter of three radial-ply tires are given in Table 1. Results of contact length measurement for radial-ply tires No. 1, 2 and 3 are given in Tables 2, 3 and 4, respectively.

**Regression Model:** A typical five-variable linear regression model is shown in equation 5 [6-11]:

$$Y = C_0 + C_1 X_1 + C_2 X_2 + C_3 X_3 + C_4 X_4 + C_5 X_5$$
(5)

Where:

Y = Dependent variable, for example contact length of radial-ply tire

 $X_1$ ,  $X_2$ ,  $X_3$ ,  $X_4$ ,  $X_5$  = Independent variables, for example section width, overall unloaded diameter, inflation pressure, vertical load and rotational speed

 $C_0, C_1, C_2, C_3, C_4, C_5 = Regression coefficients$ 

To model contact length based on section width, overall unloaded diameter, inflation pressure, vertical load and rotational speed, a five-variable linear regression model was suggested.

Table 1: Section width and overall unloaded diameter of three radial-ply tires used in this study						
Tire No.	Section width b (mm)	Overall unloaded diameter d (mm)				
1	175	578				
2	195	582				
3	185	605				

Table 1: Section width and overall unloaded diameter of three radial-ply tires	s used in this study
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Table 2: Section width, overall unloaded diameter, inflation pressure, vertical load, rotational speed and contact length (three replications) for radial-ply tire No. 1

Section width	Overall unloaded	Inflation pressure	Vertical load	sRotational speed	Contact	length L (mr	n)
b (mm)	diameter d (mm)	P (kPa)	W (kN)	N (rev/min)	 L <sub>1</sub>	L_2	L <sub>3</sub>
175	578	30	100	0	121	121	12
				600	115	115	11
				700	114	114	11
				800	113	113	11
				900	112	112	11
				1000	111	111	11
			150	0	138	138	13
			100	600	130	130	13
				700	130	130	13
				800	128	128	12
				900	120	120	12
				1000	126	127	12
			200	0		148	14
			200	600	148 141	148	14
				700	141	141	14
				800	139	140	14
				900	139	139	13
				1000	138	138	13
			250	0			
			250		157	157	15
				600 700	151	151	15
				700	150	150	15
				800	149	149	14
				900	148	148	14
				1000	147	147	14
		35	100	0	104	103	10
				600	97	97	97
				700	96	96	96
				800	95	95	95
				900	94	94	94
				1000	93	93	93
			150	0	122	122	12
				600	116	117	11
				700	115	115	11
				800	113	112	11
				900	111	110	11
				1000	109	109	10
			200	0	139	139	13
				600	135	135	13
				700	134	134	13
				800	133	133	13
				900	132	132	13
				1000	131	132	13
			250	0	151	150	15
				600	146	146	14
				700	145	145	14
				800	144	144	14
				900	143	143	14
				1000	142	142	14

					Contact length L (mm)		
Section width	Overall unloaded	Inflation pressure	Vertical load	sRotational speed			
b (mm)	diameter d (mm)	P (kPa)	W (kN)	N (rev/min)	L <sub>1</sub>	$L_2$	L <sub>3</sub>
		40	100	0	86	87	86
				600	83	82	83
				700	82	82	82
				800	80	80	80
				900	78	78	79
				1000	77	77	76
			150	0	104	104	10
				600	99	99	10
				700	98	97	97
				800	96	95	95
				900	93	94	93
				1000	91	91	91
			200	0	125	125	12
				600	119	119	11
				700	118	117	11
				800	116	116	11
				900	115	115	11
				1000	114	115	11
			250	0	134	134	13
				600	128	127	12
				700	126	126	12
				800	125	125	12
				900	124	124	12
				1000	123	123	12

 Table 3:
 Section width, overall unloaded diameter, inflation pressure, vertical load, rotational speed and contact length (three replications) for radial-ply tire No. 2

0					Contact length L (mm)			
Section width b (mm)	Overall unloaded diameter d (mm)	Inflation pressure P (kPa)	Vertical load W (kN)	sRotational speed N (rev/min)	 L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>	
195	582	30	100	0	110	110	110	
175	562	50	100	600	104	104	103	
				700	104	104	105	
				800	100	102	99	
				900	99	99	99	
				1000	98	98	98	
			150	0	129	129	129	
				600	125	125	125	
				700	124	124	124	
				800	123	123	122	
				900	122	122	122	
				1000	121	121	120	
			200	0	151	151	151	
				600	148	148	147	
				700	147	147	146	
				800	147	147	146	
				900	146	146	145	
				1000	145	145	145	
			250	0	168	168	168	
				600	164	164	163	
				700	163	163	162	
				800	162	162	161	
				900	161	161	160	
				1000	160	160	160	

ection width	Overall unloaded	Inflation pressure	Vertical load	sRotational speed	Contact length L (mm)		
b (mm)	diameter d (mm)	P (kPa)	W (kN)	N (rev/min)	L	L <sub>2</sub>	I
		35	100	0	95	95	9
				600	90	90	8
				700	89	89	8
				800	87	87	8
				900	86	86	8
				1000	85	84	8
			150	0	114	114	1
			100	600	100	100	1
				700	98	98	ç
				800	97	97	9
				900	97 96	97 96	
				1000	90 95	90 95	ç
			200				
			200	0	130	130	
				600	126	126	
				700	125	125	
				800	124	123	
				900	123	122	
				1000	121	121	
			250	0	140	140	
				600	137	137	
				700	136	136	
				800	135	135	
				900	135	135	
				1000	134	134	
		40	100	0	87	87	
				600	82	82	
				700	81	81	
				800	80	80	
				900	79	79	
				1000	78	78	
			150	0	105	105	
			150	600	99	99	
				700	98	98	
				800	98 97	98 97	
				900	97 96	97 96	
				1000	90 95	90 95	
			200				
			200	0	117	117	
				600	113	113	
				700	112	112	
				800	111	111	
				900	110	110	
				1000	109	109	
			250	0	132	132	
				600	126	126	
				700	126	126	
				800	125	125	
				900	124	124	
				1000	123	123	

Table 3: Continue

(mm)         diameter (mm)         P (kPa)         W (kN)         N (rev/min)         L1         L2           55         605         30         100         0         93         93           700         92         92         90         90         90         90           900         90         90         90         90         90         90           900         90         90         90         90         90         90           900         90         116         116         116         116           660         111         110         110         110         110           900         100         107         107         107         107           1000         107         100         107         127         127           700         124         124         124         124         124           900         124         124         124         124         124           1000         140         143         143         143         143           100         140         144         144         144         144         144         144         144	Section width	Overall unloaded	Overall unloaded Inflation pressure	Vertical load	sRotational speed	Contact length L (mm)			
85         605         30         100         0         99         99           600         93         93         700         92         92           800         91         91         90         90         90           900         89         89         89         89         89           1000         89         89         100         116         116           600         116         116         100         100         100           900         108         100         100         100         100           900         108         100         100         100         100           900         108         100         130         130         130           600         127         127         700         125         125           900         143         143         144         144           1000         123         123         123         123           900         144         144         144         144         144         144           1000         130         131         131         131         131         131         131	o (mm)					 L <sub>1</sub>	L <sub>2</sub>	L3	
600         93         93           700         91         91           900         90         90           900         90         90           900         90         90           900         90         90           900         90         90           900         90         90           900         90         90           900         90         90           900         116         116           700         110         110           700         103         100           900         124         124           1000         124         124           1000         143         143           900         144         144           700         143         143           800         142         142           900         144         144           144         144           144         144           144         144           145         143           900         73         73           900         74         74           <	85				0	99		99	
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Table 4: Section width, overall unloaded diameter, inflation pressure, vertical load, rotational speed and contact length (three replications) for radial-ply tire No. 3

					Contact length L (mm)		
Section width	Overall unloaded	Inflation pressure	Vertical load	sRotational speed			
b (mm)	diameter d (mm)	P (kPa)	W (kN)	N (rev/min)	$L_1$	$L_2$	$L_3$
			150	0	87	87	87
				600	84	84	84
				700	84	84	83
			800	83	83	83	
				900	83	83	82
				1000	82	82	82
			200	0	98	98	98
				600	95	95	95
				700	94	94	94
				800	94	94	93
				900	93	93	93
				1000	93	93	92
			250	0	109	109	10
				600	108	107	10
			700	107	107	10	
				800	106	106	10
				900	106	106	10
				1000	105	105	10



Fig. 3: Tire contact length measurement apparatus

#### **RESULTS AND DISCUSSION**

In order to model contact length of radial-ply tire based on section width, overall unloaded diameter, inflation pressure, vertical load and rotational speed, a five-variable linear regression model was suggested and all the data were subjected to regression analysis using the Microsoft Excel 2007. The five-variable linear regression model, p-value of independent variables and Table 5: Five-variable linear regression model, p-value of independent variables and coefficient of determination (R<sup>2</sup>)

	(	,				
	p-value					
Model	b	d	Р	W	N	$\mathbb{R}^2$
L = 559.7 - 0.059 b - 0.651	0.002371	1.7E-219	0	0	5.00E-66	0.9715
d - 2.930 P + 0.320						
W - 0.009 N						

coefficient of determination ( $R^2$ ) of the model are shown in Table 5. As it is shown in Table 5, this model has a high  $R^2$  value at 0.9715, indicating good agreement of the experimental data. In addition, the p-value of independent variables (b, d, P, W and N) is as follows: 0.002371, 1.7E-219, 0, 0 and 5.00E-66, respectively. Thus, based on the statistical results, this model is initially accepted, which is given by equation 6:

L = 559.7 - 0.059 b - 0.651 d - 2.930 P + 0.320 W - 0.009 N(6)

In this model, contact length of radial-ply tire can be predicted using five-variable linear regression of section width, overall unloaded diameter, inflation pressure, vertical load and rotational speed.

#### CONCLUSIONS

It can be concluded that the five-variable linear regression model L = 559.7 - 0.059 b - 0.651 d - 2.930 P + 0.320 W - 0.009 N with  $R^2 = 0.9715$  may be suggested to predict contact length of radial-ply tire based on

section width, overall unloaded diameter, inflation pressure, vertical load and rotational speed for a limited range of radial-ply tire sizes.

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#### REFERENCES

- McKyes, E., 1985. Soil Cutting and Tillage. Elsevier Science Publishing Company Inc. New York, USA.
- Wong, J.Y., 1978. Theory of Ground Vehicles. John Wiley and Sons, New York, USA.
- Bekker, M.G., 1985. The effect of tire tread in parametric analyses of tire-soil systems. NRCC Report No. 24146, National Research Council of Canada.
- Brixius, W.W., 1987. Traction prediction equations for bias ply tires. ASAE Paper No. 871622. St. Joseph, Mich.: ASAE.

- 5. Goering, C.E., M.L. Stone, D.W. Smith and P.K. Turnquist, 2006. Off-Road Vehicle Engineering Principles. St. Joseph, Mich.: ASABE.
- Azadeh, S., M. Rashidi and M. Gholami, 2013. Modeling of bias-ply tire deflection based on tire dimensions, tire inflation pressure and vertical load on tire. Middle-East J. Sci. Res., 14(1): 117-121.
- Mousavi, M., M. Rashidi, I. Ranjbar, M. Solimani Garmroudi and M. Ghaebi, 2013. Modeling of bias-ply tire contact area based on tire dimensions, tire inflation pressure and vertical load on tire using linear regression models. Am-Euras. J. Agric. & Environ. Sci., 13(5): 627-632.
- Oroojloo, M., M. Rashidi and M. Gholami, 2013. Modeling of radial-ply tire contact area based on tire dimensions, tire inflation pressure and vertical load on tire. Middle-East J. Sci. Res., 17(7): 949-954.
- Sheikhi, M.A., M. Rashidi and M. Gholami, 2013. Modeling of radial-ply tire deflection based on tire dimensions, tire inflation pressure and vertical load on tire. Am-Euras. J. Agric. & Environ. Sci., 13(2): 222-226.