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Load Deflection Relationships for Three Log-Skidder Tires

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SUMMARY

Load deflection curves and regression equations are presented for three skidder tires at two inflation pressures. The tires tested were a IO-ply 18.4-34, a 12-ply 24.5-32, and a 12-ply 30.5L-32.

INTRODUCTION

Recent cooperative studies (Burt et al. 1982, Iff et al. 1982) by the U.S. Forest Service and the National Tillage Machinery Laboratory (NTML) demonstrated the need to develop load-deflection relationships for tires used on articulated, four-wheel drive, rubber-tired skidders. Load deflection curves were needed to determine such factors as rolling radius, tractive performance, and skidder stability. These curves can also be used to help loggers determine the right combination of tire size and inflation pressure for different load conditions. Earlier studies by Biller (1972) have shown that matching the proper tire size for specific load conditions would reduce many of the problems that loggers have with skidder tires. The purpose of this paper is to summarize the load of deflection results developed from these earlier studies at the NTML.

MATERIALS AND METHODS

The single-wheel tire tester and other facilities of the NTML were used to obtain the load deflection relationships. The testing capabilities of the single-wheel tire tester have been described in detail by Burt et al. (1980).

Three skidder tires (fig. 1) were selected to represent a range of sizes that are currently being used on articulated, four-wheel drive, rubber-tired skidders operating in southern forests. The three skidder tires used in this study, supplied by Firestone Tire and Rubber Company[1], Akron, Ohio, were a 10-ply 18.4-34, a 12-ply 24.5-32, and a 12-ply 30.5L-32.

The load deflection tests were run with the tires at a stationary (non-rotating) condition. During each test, the dynamic load was increased uniformly and continuously from 0 to approximately 10,000 pounds and then decreased uniformly and continuously back down to 0 pounds. By obtaining tire deflection measurements as a function of increasing and decreasing dynamic loads, an indication of tire hysteresis was obtained. Each tire was tested on a rigid surface at inflation pressures of 15 and 25 psi.

ANALYSIS AND RESULTS

Tire deflection measurements were obtained at approximately 30-pound intervals. For each test, there were about 300 data points for tire deflection as a function of increasing dynamic load, and about 300 data points for tire deflection as a function of decreasing dynamic load. Since a graphical analysis of the data indicated only a small hysteresis, and skidder tires under forest conditions are sub-

[1]The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others that may be suitable.

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Figure 1.-Skidder tires used in load deflection tests (18.4-34 on left, 30.5L-32 in center, 24.5-32 on right).

jected to sudden dynamic load changes, the tire deflection data (increasing and decreasing dynamic load) were combined for the regression analysis.

The general form of each regression equation was: $y = a + bx + cx^2$. In the model, y was tire deflection, a was the vertical axis intercept, x was dynamic load, and b and c were the regression coefficients to be determined. Because the definition of tire deflection is zero at zero dynamic load, the constant a (vertical axis intercept) in the above model was always zero. The developed regression equations are shown in table 1, and their graphical forms are shown in figures 2-4.

DISCUSSION

For the same dynamic load and inflation pressure, a reduction in tire size was associated with an increase in tire deflection. As dynamic load increased, the lower inflation pressure (15 psi) was associated with a progressive increase in deflection for the smallest (18.4-34) and largest (30.5L-32) tires. The middle-sized tire (24.5-32) behaved differently from the other two. It had a higher tire deflection at the higher inflation pressure (25 psi) than at the lower inflation pressure (15 psi) for dynamic loads up to about 6,500 pounds. A possible explanation is the difference in sidewall position at the various inflation pressures. At lower inflation, the sidewalls could have been supporting a significant amount of the load in a manner analogous to a column. When the tire was inflated to the higher pressure, the sidewall could have been curved due to the increased pressure, thereby reducing the load-carrying capacity of the sidewall. For loads up to 8,000 pounds at the higher inflation pressure (25 psi), average tire deflection per thousand pounds was about 0.47 inches for the 18.4-34, 0.38 inches for the 24.5-32, and 0.34 inches for the 30.5L-32.

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Table 1 .-Load-deflection regression equations for the three skidder tires

Tire size	Inflation pressure	Regression equation*	R^2	C.V.
18.4-34	15 psi	$Y=0.000743(x)-0.0000000193(x)^2$	0.94	5.20
18.4-34	25 psi	$Y=0.000689(x)-0.0000000268(x)^2$	0.87	6.23
24.5-32	15 psi	$Y=0.000518(x)-0.0000000146(x)^2$	0.91	6.82
24.5-32	25 psi	$Y=0.000589(x)-0.0000000266(x)^2$	0.91	6.35
30.5L-32	15 psi	$Y=0.000518(x)-0.0000000138(x)^2$	0.95	7.29
30.5L-32	25 psi	$Y=0.000426(x)-0.0000000112(x)^2$	0.95	6.32

*Y = tire deflection, in inches.
X = dynamic load on a single tire, in pounds.

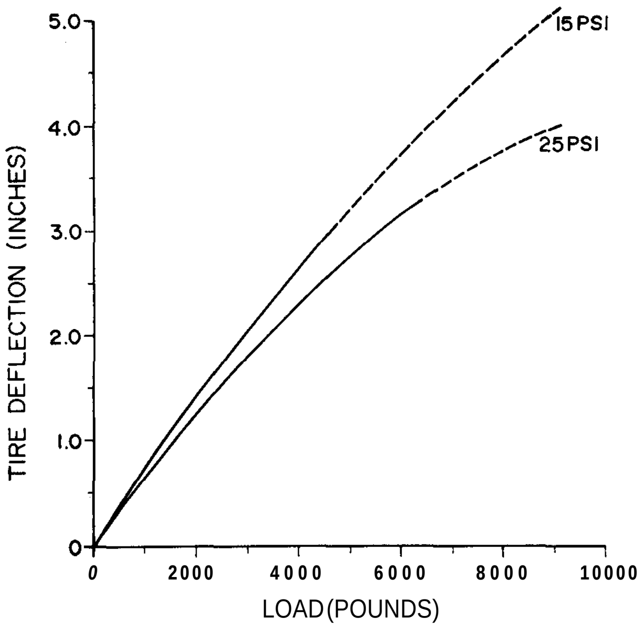

Figure P.-Load deflection curves for the 18.4-34 skidder tire (dashed line segments indicate test loads beyond manufacturer recommendations).

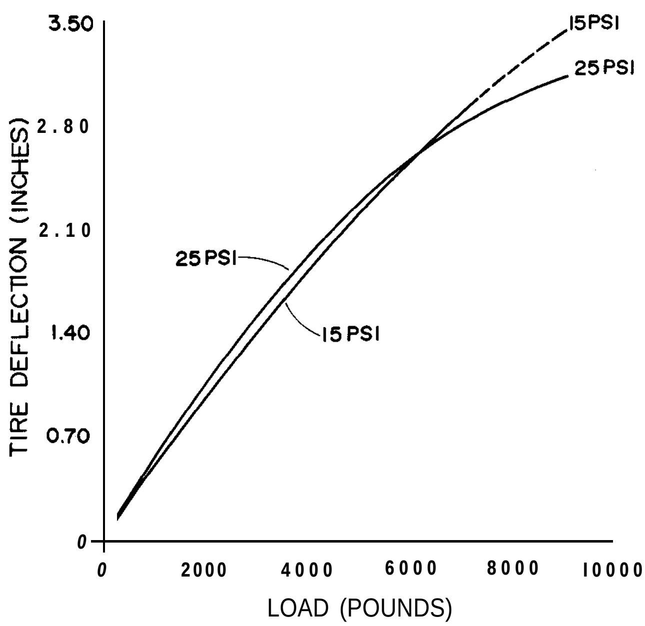

Figure 3.—Load-deflection curves for the 24.5-32 skidder tire (dashed line segments indicate test loads beyond manufacturer recommendations).

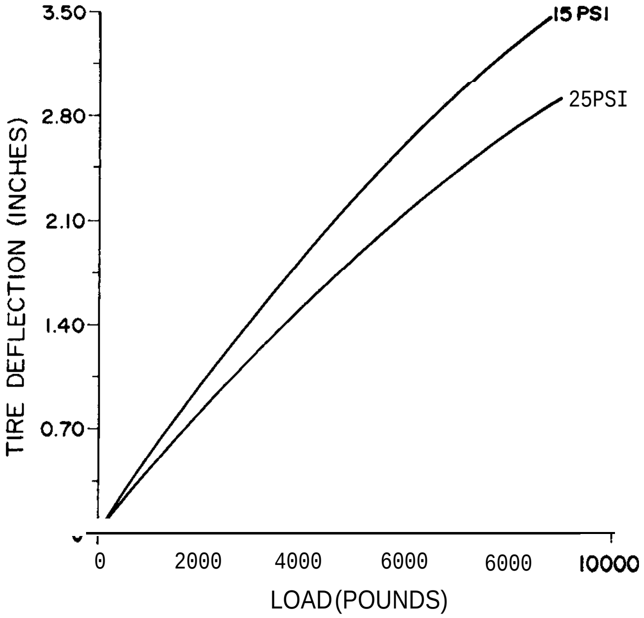

Figure **4.—*Load-deflection*** *curves for the* ***30.5L-32*** *skidder tire (dashed line segments indicate test loads beyond manufacturer recommendations).*