4Runner 23.4mm OME-Blazeland Load Cpacity.mcdx

Prepared By A. Parker

01/09/2022

GIVEN: Torsion bar geometry values and suspension travel range for the 2nd Gen 4Runner (y)

- Torsion bars functional length (L) = 37.00 (41.875 inches Sway-A-Way)
- Torsion bar diameter (D): OEM = 22.8mm, OME = 23.5mm, SAW = 25mm, Downey = 26mm
- Upper A-Arm length (A) with Blazeland installed is +3.5" OEM = 8.5+3.5 = 12.0 inches
- Suspension travel range (y) approximatley 10 inches.

FIND:

- Angular deflection as a function of the wheel travel
- Find the effective forshortening of the A-arm as it deviates from horizontal orientation.
- Torsional Deflection as a function of angular movement based on travel range.
- The effective spring rate (K) with forshortened A-arm length superimposed.
- The load capacity (LC) of two torsion bars for various compressed distances and plot curve.

ASSUMPTIONS:

- Material Chrome Vanadium UNS G61500 or Chrome Silicon UNS G92540
- The shear modulus (G) for Chrome Vanadium and Chrome Silicon (c/o Murphy & Read Spring Mfg.) 11,500,000 psi
- A-Arm at horizontal to ground establishes full arm length (A)

SOLUTION: Variables $L := 37\ in$ $D := 23.4\ mm$ $G := 11500000\ psi$ $A := 12.0\ in$

$D = 0.92\ in$

$$y := \begin{bmatrix} 10.0 \\ 9.0 \\ 8.0 \\ 7.0 \\ 6.0 \\ 5.50 \\ 5.0 \\ 4.0 \\ 3.0 \\ 2.0 \\ 1.0 \\ 0.01 \end{bmatrix} in \qquad \alpha := \operatorname{asin}\left(\frac{y}{A}\right)$$

$$y' := \begin{bmatrix} 5.0 \\ 4.0 \\ 3.0 \\ 2.0 \\ 1.0 \\ 0.01 \\ 1.0 \\ 2.0 \\ 3.0 \\ 4.0 \\ 5.0 \\ 6.0 \end{bmatrix} in$$

y' value sets values from horizontal as 0.01. Top-out is 6.0 and bottom-out is 5.0

$$\alpha' := \operatorname{asin}\left(\frac{y'}{A}\right) \qquad A' := \cos(\alpha') \cdot A = \begin{bmatrix} 10.91 \\ 11.31 \\ 11.62 \\ 11.83 \\ 11.96 \\ 12 \\ 11.96 \\ 11.83 \\ 11.62 \\ 11.31 \\ 10.91 \\ 10.39 \end{bmatrix} in$$

A' is the foresohortened length of the A-arm for angles that deviate from horizontal.

ANSWER: Torsional deflection for a torsion bar (Engineering Tool Box), Force developed with forshortenend effective A-Arm length, Spring rate (K) with F calculated using A', Load Capacity (LC). All as a function of wheel travel (y).

$$T := \frac{\alpha \cdot G \cdot \pi \cdot D^4}{32 \cdot L} \qquad F := \frac{T}{A'} \qquad K := \frac{F}{y} \qquad LC := 2\ F$$

$$y = \begin{bmatrix} 10 \\ 9 \\ 8 \\ 7 \\ 6 \\ 5.5 \\ 5 \\ 4 \\ 3 \\ 2 \\ 1 \\ 0.01 \end{bmatrix} in \qquad T = \begin{bmatrix} 1804 \\ 1553 \\ 1337 \\ 1141 \\ 959 \\ 872 \\ 787 \\ 622 \\ 463 \\ 307 \\ 153 \\ 2 \end{bmatrix} ft \cdot lbf \qquad F = \begin{bmatrix} 1985 \\ 1648 \\ 1380 \\ 1157 \\ 962 \\ 872 \\ 790 \\ 631 \\ 478 \\ 325 \\ 168 \\ 2 \end{bmatrix} lbf$$

$$K = \begin{bmatrix} 198.5 \\ 183.1 \\ 172.6 \\ 165.3 \\ 160.4 \\ 158.6 \\ 158 \\ 157.8 \\ 159.3 \\ 162.7 \\ 168.1 \\ 176.3 \end{bmatrix} \frac{lbf}{in} \qquad LC = \begin{bmatrix} 3970 \\ 3295 \\ 2761 \\ 2314 \\ 1925 \\ 1744 \\ 1580 \\ 1263 \\ 956 \\ 651 \\ 336 \\ 4 \end{bmatrix} lbf$$