30th August 2005
Version 1.0

WHITELINE AUTOMOTIVE
PO Box 5666, Minto, NSW, 2566 Australia
Ph: 61 2 9603 0111 Fax: 61 2 9820 2500
E-mail: admin@whiteline.com.au
A.B.N. 68 073 002 034

Flat out

Discussion Paper

Calculating and Comparing Swaybar Link Compliance.

How to calculate relative stiffness of different types of links using compliant materials. Example used is for Subaru rear alloy links fitted with polyurethane bushes.

Prepared by

Jakub Zawada B.E. (Mech)

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Assuming we would like to compare the relative stiffness of different link materials where the links are otherwise identical except one has compliant bushes at both ends.

Non-compliant Links

Assuming the link is just a straight tension-compression member, the stiffness of the non-compliant link is simply the stiffness of the material it's made of, which can be calculated as:

K (non-comp) = K

Where K = A*E/L
A = cross sectional area
E = material modulus
L = length

Compliant Links

For the compliant link we have in effect 3 springs in series, the 2 softer springs at either end representing the compliant bushes. The effective spring rate of this is:

K (comp) = k*K/(2*K+k) up until the bushes max out in travel

= K for travel beyond the bush max out travel.

Where K = stiffness as above in non-compliant case
k = stiffness of the individual bushes

This gives a low stiffness value up until the bushes reach their limit, then it has the same stiffness as the non-compliant link.

For example, assume the link is made of AL (aluminium) and is 20 mm x 15 mm x 100 mm long, this delivers a stiffness of 210 000 N/mm for a non-compliant.

The bushes each have a stiffness of 20 000 N/mm but can only travel a max of 2 mm, therefore the stiffness of the compliant link is only 9545 N/mm up to a deflection of 4 mm (2 bushes at a max of 2mm). From there on it will operate at 210 000 N/mm. See figure below.

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Forces VS Deflection example.