

# For the mathematically minded - the discovery of gamma minus, or what's wrong with Annex M?

By Dr Gina Barney.

You will all have heard of the nuclear physicists search for the omega minus. Well I have been looking for the gamma minus.

You will no doubt have looked at Annex M in EN81 and said - "Too complicated for me". But did you get someone to program it up for you and use it? Well the English version is incorrect!

My thesis was that the new traction calculation formulae should give similar answers to the old BS5655 calculations within a few percent. I had no problem with reconciling the LHS ( $T_1/T_2$ ) once I had removed the inertial terms. But the RHS ( $e^{f\alpha}$ ) defeated me, particularly the Friction Factor  $f$ .

BS 5655-1:1986 gives the formula for the Friction Factor for semi circular and semi circular undercut grooves as:

$$f = \mu \frac{4(1 - \sin \frac{\beta}{2})}{\pi - \beta - \sin \beta}$$

BS EN81-1: 1998, Section M.2.2.1.1 (English version) gives a formula for the Friction Factor:

$$f = \mu \frac{4(\cos \frac{\gamma}{2} - \sin \frac{\beta}{2})}{\pi - \beta - \gamma \sin \beta + \sin \gamma}$$

This improves the 1986 formula by introducing  $\gamma$  the value of the groove angle. This was assumed to be zero in 1986, but now the value of the angle can be up to 25°. The value of the friction coefficient was also changed from 0.09 to 0.1.

Putting  $\gamma$  to zero causes the numerator terms of both equations to equate, but makes the denominator for the 1998 formula equal to  $\pi - \beta$ , which is not correct.

In his excellent paper on Annex M, Dr Gerhard Schiffner in Lift Report 2/2000 page 46, gives the formula:

$$f = \mu \frac{4(\cos \frac{\gamma}{2} - \sin \frac{\beta}{2})}{\pi - \beta - \gamma - \sin \beta + \sin \gamma}$$

Note the extra minus in the denominator term, after the gamma ( $\gamma$ ).

Putting  $\gamma$  to zero now causes the 1986 and 1998 formula to closely correspond.

So what you say.

Let us calculate three values for the RHS ( $e^{f\alpha}$ ) for each of the formulae for:

$\beta=1050$ ;  $\gamma = 250$ ;  $\mu = 0.09$  for 1986 and 0.1 for 1998; angle of wrap = 165°.

BS5655: 1986	BS EN81-1: 1998 (English)	DIN EN81-1: 1998 (German)
1.87	1.17	1.83

**The English version is more than a few percent in error wouldn't you say? I hope not many of you have used the English formula, else your traction will be wrong.**