RUBBER TESTING - Indoor News Issue 21, Feb 1993 by Bernard Hunt (GB) At the US Nats last year I broke all my favourite Pirelli in the hot conditions so I borrowed some Tan FAI from Jack McGillivray and as I liked it set out to acquire more and test it against Pirelli.

My old method of testing involved winding/unwinding F1D sized motors and noting turns-torque using an accurately calibrated torque meter. This works OK but it is time consuming and frustrating as you have to wind to the limit to get meaningful results and so blow many motors.

I read an article by the regular rubber tester, Fred Pearce, in the 1990 NFFS Symposium where he describes the stretch method for testing F1B sized motors. This involves breaking in by stretching a motor to a predetermined stress (load per cross section) and then testing by stretching to the limit and measuring the load- extension on relaxation to get the energy characteristics of the rubber. The assumption is that stretch testing and winding give comparable results. I have adapted this method to indoor rubber sizes and found it to be very quick and reproducible and the energy figures were in pretty good agreement with the winding method. To do stretch tests you need a kitchen scale, preferably an electronic one with a maximum load of 2 kg or more, a 2 kg weight (a lump of lead) with a smooth hook fitted and a wall with 2in (5cm) divisions marked up to 72in (180cm) high (ruler or tape measure better). Make up an 8 in (20cm) loop of rubber (just like a motor) of 0.3 - 0.4 grammes but accurately weighed (W). Lube the rubber, zero the scale, and place the 2-kg weight on the scale. This gives the zero load reading (F1). Now hook the rubber onto the weight and stretch the rubber upwards using a pencil or nail, the reading on the scale falls as you do so. Keep lifting the nail until the rubber is solid, note the scale and ruler reading, and hold the position for 2 min. (this breaks in the rubber). Lower the nail and relax the rubber and repeat the process for the 2nd break-in.

Now we are ready for the test proper. Repeat the stretch until the rubber is solid (or better to a calculated stress of 7000 psi = 5. 5 kg/mm2 at 8 or so times stretch - remember the section is for 2 strand), don't hold the position but note the scale reading (F2) and ruler (L2), now relax the rubber in 2in (5cm) steps noting the scale readings (F) and the ruler readings (L), repeating this until the rubber is back to its original unstretched length (L1).

We can now plot a graph of load (F1-F) in grammes versus extension (L-L1) converted to centimeters. The area under this graph divided by the rubber weight (W) in grammes is the specific energy of the rubber.

My own preference is to calculate a normalised [i.e. standard weight (X) and maximum extension (Y)] version of the load versus extension plot which enables the shape of the curve and the 'cruise' load (= torque) to be seen regardless of the size of the piece of rubber tested or its hardness/softness. The load=torque at 50% of max stretch is probably the most useful figure.

Now for the important bit - the actual results. In the nice warm conditions (75 °F) of my

tests, 1991 Tan FAI (ex Mike Woodhouse or direct from FAI) proved excellent - fully equal to my best Pirelli with an energy of 115,000 - 125,000 cm. 1989 Tan FAI was also equally good but two different identities of 1990 Tan were poor with energies of 93000 - 95000 cm. Tan FAI handles well in indoor use it tends to break at the knot (so can be re-tied) although it is rather tricky to re-tie after lubing. I have had no problems with whiskering.

I have flown EZB, Penny Planes and FlD on hot days at Cardington with Tan FAI during Aug/Sept 1991 and I have to admit that I like the stuff a lot. I have done my best times ever in Novice Penny Plane (14'30) and US rules EZB (25'06 and an amazing 26'38) and won the FlD Team Trials to boot! I have only flown once on a cold day and Pirelli climbed better than Tan. It will be interesting to see how Tan copes with icy Wigan in February.

It looks like you need to use about 10% thicker and l0% shorter motors using Tan to get the same turns as Pirelli and you fly with much less back off.

Well there it is! I've tried to describe my stretch testing method for indoor rubber and I hope it is clear enough for people to try but if anyone has a problem write to me at 4 Ashfield Ave, Skelmanthorpe, HUDDERSFIELD HDO 9BW, UK.

Footnote:

Normalised load = (F1 - F) * (L2 - L1) / Y * X / W
Normalised extension = (L - L1) * Y / (L2 - L1)

I use X = 1 qramme and Y = 100 inches (say 200 cm) for easy plotting. Replace load by torque and extension by turns in these formulae to normalise torque/turns tests.

I always use a computer programme to calculate the normalised data and energy. A copy of the listing written for Sharp PC1450 or similar is shown below.

```
5000: "Z" REM "ENERGY CALC"
5010: CLEAR
5011: USING
5012: INPUT "LPRINT (Y/N)" ; P$
5015: INPUT "RUBBER TYPE = " ; T$
5019: INPUT "TEMP = " ; TE
5030: INPUT "WT = " ; W
5040: INPUT "MAX LENGTH = " ; L2
5050: INPUT "ORIG LENGTH = " ; Ll
5060: INPUT "ORIG BAL READING = "; Fl
5061: IF P$<>"Y" THEN GOTO 5070
5062: LPRINT D$
5063: CURSOR 0: LPRINT "R TYP= " ; T$
5064: LPRINT "WT = "; W;" * " ; Ll; " IN T = " ; TE
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```
5065: LPRINT " LEN READ NEXT NFORCE "
5066: LPRINT "*10in GM * 10in GM"
5067: LPRINT
5070: INPUT "LENGTH = " ; L
5080: INPUT "BAL READING = "; F
5081: USING "#####" ;
5082: PRINT "NORM EXTEN = " ; ( L - L1 ) * 100 / ( L2 - L1 )
5084: PRINT "NORM FORCE = " ; (F1 - F ) * ( L2 - L1 ) / ( 100 * W )
5085: IF P$ <> "Y" THEN GOTO 5090
5086: LPRINT 10 * L; F; 10 * ( ( L - L1 ) * 100 / ( L2 - L1 ) ); " " ;
( Fl - F) * ( L2 - L1 ) / (100 * W ) 5090: IF L < L2 THEN LET E = E + ( Fl - F + X ) *
( Y - ( L - L1 ) ) / 2
5100: X = F1 - F: Y = L - L1
5110: IF L - L1 > 0 THEN GOTO 5070
5115: IF P$<>"Y" THEN GOTO 5120
5116: USING "#######": LPRINT "ENERGY = "; E / W * 2.54
5120: USING "#######"
5130: PRINT "ENERGY = "; E / W *2.54
```