Variation of Calibration Constant with Surface Texture, Part 2: Effects on Course measurements by Seven Riders using Twelve Tyres

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Introduction

In Part 1 of this article which appeared in last month's ***MN*** 89 p 12, I reviewed the published data on the sensitivity of tyres to the surface texture. Here I will report measurements of a race course using different tyres. I will summarise the different behaviour of solid and pneumatic tyres. I shall also point out the circumstances which could lead to short courses.

Abingdon 4.5 km Course

Last September I needed a course for use during a measurement seminar for beginners. I chose a loop route which was moderately twisty and contained a number of features that would test adherence to the SPR. It can usually be ridden without encountering obstructions which would slow down measuring and could introduce additional error. The course is shown in figure 1. Part of the course lies along the South side of my Long Tow calibration course. This is the calibration course which I discovered gives me a calibration constant which varies according to whether I ride on the rougher surface near the edge of the road 0.3 to 0.5 m from the kerb, or where vehicles have worn a smooth track approximately 1.1 to 1.3m from the kerb, see ***MN*** 75 p36 and ***MN*** 89 p15.

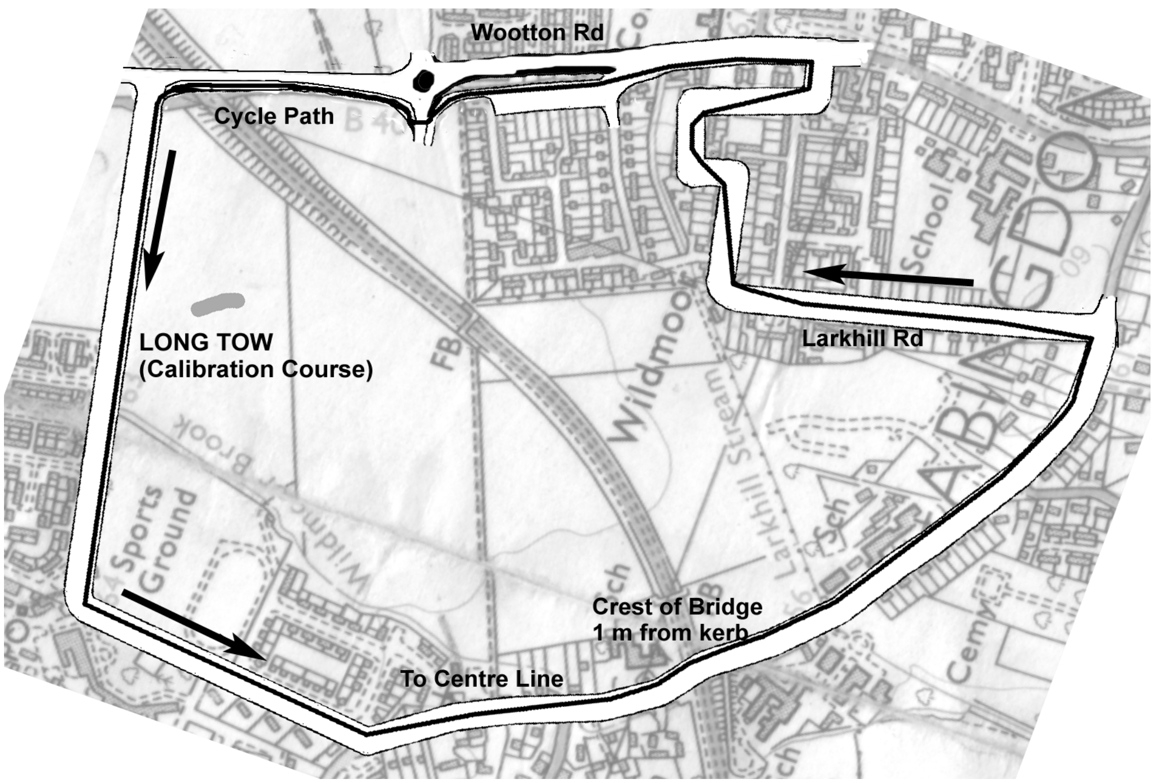


Figure 1. Abingdon 4.5k Course. The route is mostly 30 cm from the left hand kerb, except the full width is used along minor residential roads. A diversion round permanently parked cars is marked with white paint on the road.

My initial aim was to have a well defined course so that I could readily identify faults with beginners' measurements. But I then realised it could be used for a practical test of the importance of surface texture, since I could choose either the rough or smooth surface of Long Tow carry to out calibration and then ride the loop which has various surface changes throughout its length. I have the impression that the average roughness of the course is probably intermediate between the two Long Tow surfaces, but this is a hard judgment to make even qualitatively, since I have no way other than bike measurements of checking and so calibrating my eyeball judgments.

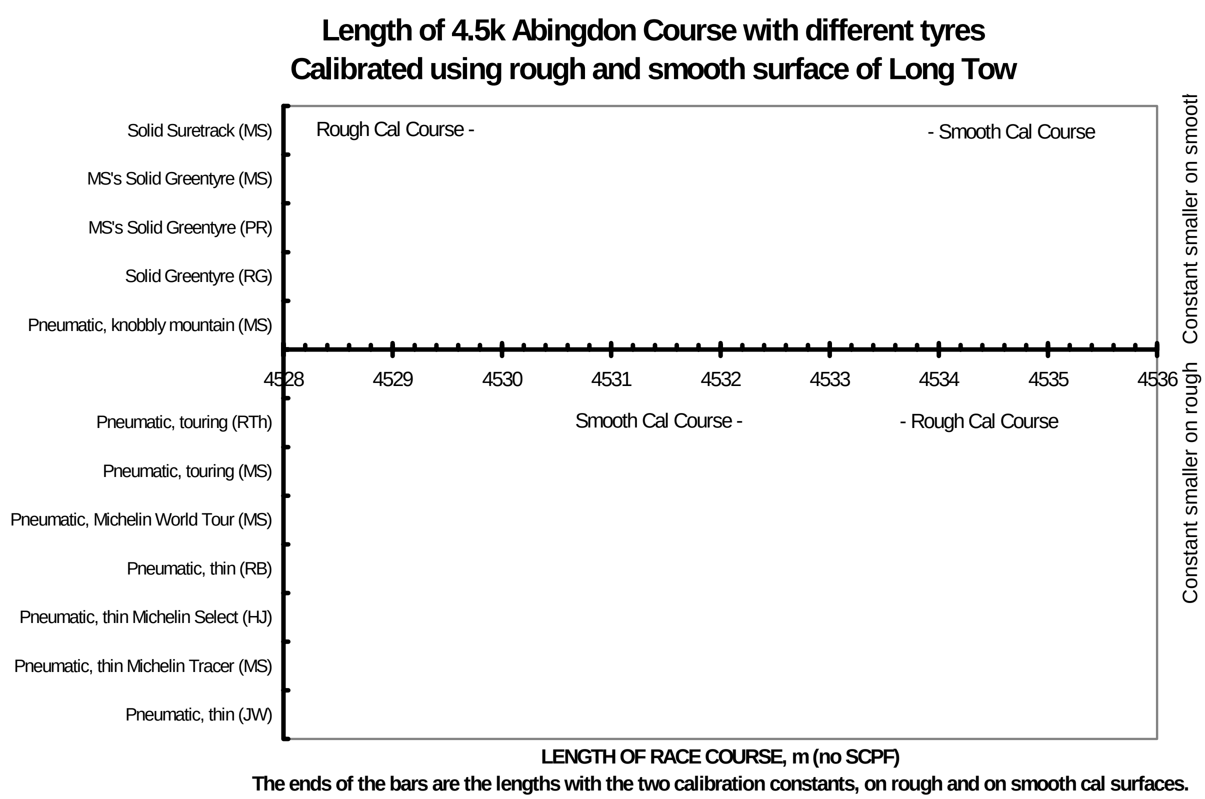
Since I wanted to study how different tyres behaved I carried out rides with six of different tyres. With each tyre my ideal full measurement sequence was as follows, 4 ride calibration on rough Long Tow, 4 ride calibration on smooth Long Tow, 2 rides of loop, repeat both calibrations. This sequence takes approximately 90 minutes to carry out. Sometimes I was only able to carry out one loop ride between the two pairs of calibrations variations. In these cases I always ensured I repeated the whole sequence on another occasion so getting a second completely independent loop measurement. For all my own rides I thus obtained with each tyre at least two and sometimes three rides of the loop with pre and post calibration on both Long Tow surfaces. The agreement between identical rides was typically better than 0.5 m, even for rides weeks apart. The average values are given in table 1.

In order to widen the range of tyres and to see if different riders would produce the same results, I had measurements made by the 5 experienced measurers who were attending an in-service training seminar on 13 September 1997, we carried out the sequence, 4 ride calibration on one surface of Long Tow, one ride of loop, a pair of 4 ride calibrations on both rough and smooth Long Tow surfaces.

Finally when Pete visited in April he and I both carried out a single ride of the loop sandwiched between two pairs of calibrations. On this occasion Pete used my bike and my solid Greentyre, thus providing a test to see to what extent the effects would be reproducible when only the rider was changed.

	RIDER	ROUGH	SMOOTH	DIFFERENCE
RG's Solid Suretrack	M.Sandford	4529.8	4533.8	4.0
MS's Solid Greentyre	M.Sandford	4530.8	4534.3	3.5
MS's Solid Greentyre	P.Riegel	4531.3	4535.1	3.8
RG's Solid Greentyre	R.Gibbons	4531.2	4533.0	1.8
MS's Pneumatic, knobby mountain	M.Sandford	4533.0	4533.7	0.7
RTh's Pneumatic, touring	R.Thornhill	4533.5	4532.3	-1.2
MS's Pneumatic, touring	M.Sandford	4533.4	4532.1	-1.3
MS's Pneumatic, Michelin World Tour	M.Sandford	4533.6	4532.2	-1.4
RB's Pneumatic, thin	R.Bright	4531.3	4530.1	-1.2
HJ's Pneumatic, thin Michelin Select	H.Jones	4530.9	4529.1	-1.8
MS's Pneumatic, thin Michelin Tracer	M.Sandford	4534.3	4531.4	-2.9
JW's Pneumatic, thin	J.Webber	4534.5	4531.1	-3.4

Table 1. Length m of Abingdon 4.5k course using the rough or the smooth part of Long Tow for calibration. The difference is the smooth calibration - the rough calibration.



Shortest Possible Route

I estimate the course has 3 full 360 degree of turns. So if every corner is ridden an *average* of 5 cm inside the SPR the course will be measured short by 1 m. Conversely, if the rider is on average 5 cm outside the SPR, the course will be measured long by 1 m. This total range of +/- 5 cm from the SPR may seem rather small, particularly in relation to the tyre width of 3 cm, but I believe it is realistic for the following reasons:

It is the average kerb clearance which causes an error in length. Superimposed on the average kerb clearance may be larger 'wobbles' of up to +/- 15 cm which will have little effect provided they are also present in the calibration course riding.

The course mainly had sharp corners. The experienced measurers took great care round these corners. At other places since the total curvature was less, errors in kerb clearance were less important.

On most corners the 30 cm distance from the kerb could be judged by reference to a 25 cm wide concrete gully. The bikes were ridden just outside this concrete. On some corners where there was no gully I marked the line with a lumber crayon. Although the experienced measurers had only one measurement ride round the loop. I showed them the critical points before their ride, and accompanied them to provide guidance and observe their performance which appeared very good.

My own rides were reproducible with a standard deviation of less than 0.3 m. While this does not by itself prove that I ride the correct SPR, it shows the variation of my route is insignificant.

My overall conclusion is that when comparing my rides, one with another, SPR errors are significantly less than 1 m. When comparing rides of different experienced measurers, errors of 1 m are possible and 2 m is probably the upper limit. This is confirmed by the rides of PR and MS, which agreed within 0.8 m when using the same solid Greentyre. Most of the differences which were seen between pneumatic and solid tyres were undoubtedly due to surface texture affecting the calibration constant.

Conclusions about Tyres

In Table 1 the tyres are ordered by the difference of course length with smooth surface calibration - course length with rough surface calibration. All the solid tyres have a positive value of 1.8 to 4 m for this difference. Only one pneumatic tyre has a positive value, the knobbly mountain tyre which has a value of 0.7 m. I note that the thick tread of this tyre may have some of the characteristics of a solid tyre.

By contrast all the pneumatic tyres have a smaller value for the difference than any of the solid tyres. In fact except for the thick tread mountain bike tyre they all have negative differences between - 1.2 and - 3.4 m. Further data is needed to identify the reason for the slightly different behaviour of the different pneumatics. It is possible that thickness of the tread on the pneumatic, which could give it properties like a solid tyre may be balanced against properties of the pneumatic which arise from the tyre casing being stretched by internal air pressure. I hypothesise that the stretched casing will give a negative value for the difference in my experiment. But when a pneumatic tyre is has thick tread the effect of the solid rubber just outweighs that of the pneumatic casing giving a difference of + 0.7 m. But for the two touring tryes which have a tread a few mm thick the pneumatic effect is dominant giving a difference of - 1.3 m. Perhaps a tyre with intermediate tread thickness would be independent of surface roughness.

Of the pneumatic racing tyres which do not have much tread, two give large negative values which fits the hypothesis. The other two give smaller differences also the overall lengths are 2 to 3 m shorter than the other pneumatic tyres. This is not explained by my hypothesis and needs further study.

Conclusions about Courses

The most serious problem which this work shows is that with the modest but noticeable difference in roughness of the Long Tow calibration surface 0.9 m further towards the centre of the road, the length that an experienced measurer gets for a course can vary depending on tyre and surface from 4529.1 m to 4534.5 m a range of 5.4 m when the SCPF is 4.5 m.

We should minimise the consequences of these effects by always using a calibration course that is representative of the average surface of the course to be measured. Sometimes this might best be done by laying a calibration course out on the actual race course. Secondly we should pick a tyre which is not sensitive to surface. Some pneumatic tyres appear to be superior in this respect to solid tyres and other pneumatic tyres. Thirdly, until we can fully quantify these effects, validation is probably better done using the same calibration course surface as for the original layout. It would be unfortunate if surface texture contributed to a course failing validation.