TUBULAR TIRES: ADHESIVES AND PRACTICE
PART 6

Adhesive Performance at Higher Temperatures

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On high speed descents, a rider may apply sufficient braking to heat the rims to high enough temperatures such that touching them would burn - nominally 60 ^oC (140 ^oF). While expert descenders may apply their brakes more prudently resulting in less heating, rims will still heat to temperatures substantially above ambient.

Suppose a clincher tire is inflated to 100 lb_f/in^2 (gauge) at a temperature of 21 ^oC (70^oF). If the tire temperature were to rise to 60 ^oC (140 ^oF), the pressure would rise to 115 lb_f/in^2 (gauge) in the tire, a pressure rise of only 1 bar. This would not stress the tire/rim clinch assuming good condition of the tire and rim. The likelihood of a blowout due to over-pressure alone is nil.

If a tubular tire is used and subject to the same heating, the pressure rise would be equivalent. However, the interface between the tire and the rim is no longer a rim hook and tire bead. The interface is an adhesive. So while the tubular is unlikely to blowout due to the temperature rise, if the adhesive properties change with temperature, the tire may be more prone to roll-off. If the high temperature is experienced during high-speed, curving descents which place severe lateral load on the adhesive and if the adhesive performance degrades, the likelihood of roll-off increases and this could lead to serious rider injury.

Tubular tire - rim combinations are attractive for their light rotating mass and low weight. Riders will continue to select them because of these properties. Proper adhesive selection and proper application are necessary to minimize the potential for roll-off. Given the temperature rise due to braking during descents, the subsequent lateral stress placed on the adhesive bonds in corners and slides and the potential for serious injury to the rider, it is important for the mechanic to know how the adhesive will perform.

The purpose of this article is to examine adhesive performance as a function of operating temperature. This is the sixth in a series of articles examining the proper use and the expected performance of various commercially available adhesives, rims and tires. Previous articles have dealt with:

1) The proper installation of tubular tires;

2) The proper adhesive application procedure;
3) The impact of various combinations of adhesives, rims and tires; and,
4) The effect of curing time.

The recommendations given in these articles are based on extensive experience and on extensive laboratory measurements. The latter were developed to emulate actual road and riding conditions but are necessarily approximate. Mechanics are advised to incorporate these observations with their own experiences so as to provide maximum safety to the rider.

Effect of Operating Temperature

As with previous experiments, the recommended gluing procedure was followed.

1) An adhesive coat was spread uniformly on the rim.
2) An adhesive coat was spread uniformly on the base tape of the tire using an acid brush.
3) After 24 hours, a second coat was spread on the rim.
4) After another 12 hours, a third coat was spread on the rim.
5) When this third coat became tacky, the tire was mounted on the rim.
6) The adhesive holding the tire to the rim was allowed to cure for 24 hours at room temperature.

As with the other experiments reported in this series of articles, the short rim - tire section static method was used as the protocol.

Once the adhesive was cured, the samples were placed in an appropriately controlled temperature environment for 1/2 hour. At the end of this period, the torque required to roll off the tire was then measured. The rims and tires used for all measurements were anodized aluminum rims and Ultech Nomad tires. As with previous articles, the results were then scaled to Vittoria Mastik'One's room temperature performance.

Figures 1, 2 and 3 show the performance of the seven adhesives tested for this study. Performance for other rim - tire combinations would be similar. The grouping in the figures is based on the performance as the operating temperature rises. Table 1 provides an approximate relative performance.

Table 1

Adhesive Performance Relative to Mastik'One

Part A: **Performance Relative to Mastik'One at Room Temperature**
(Basis of the Figures - Used to Indicate Loss of Performance due to Temperature)

Adhesive	23°C	60°C
Vittoria Mastik'One	100	65
Continental	90	45
Vittoria Gutta	75	30
3M Fast Tack	60	35
Clement	80	15
Wolber	60	20
Pana Cement	50	25

Part B: **Performance Relative to Mastik'One at the Specific Temperature**
(Used to Indicate Loss of Performance Relative to Mastik'One)

Adhesive	23°C	60°C
Vittoria Mastik'One	100	100
Continental	90	70
Vittoria Gutta	75	45
3M Fast Tack	60	55
Clement	80	25
Wolber	60	30
Pana Cement	50	40

In Figure 1, the performance of Vittoria Mastik'One and Continental adhesives is plotted. Interpolating lines for the actual measurements are included merely for convenience and do not imply any functional relationship. Note that as the temperature rises, the bond strength falls markedly. For Mastik'One, the strength falls to only 65% of its original value. Continental falls to about 50% of its original value (45 divided by 90 using the Table 1, Part A figures). Both adhesives exhibit loss of performance as temperature rises. Since the Continental performance is 90% of Mastik'One's at 23°C but only 70% (45 divided by 65 in Table 1, Part A) of Mastik'One's performance at 60°C, Continental is more sensitive to temperature in this set of experiments.

Consider Figure 2. The performance of Vittoria Gutta and 3M Fast Tack are compared. As discussed in earlier articles, their performance at room temperature is not as high as the previous two adhesives. Note that Gutta and Fast Tack are about 75% and 60% of Mastik'One's room temperature strength. At higher temperatures, Gutta retains only 40% of its original strength or 45% of Mastik'One's strength at the higher temperature. Gutta exhibits a stronger degradation with temperature than Mastik'One does as indicated by its relative loss in strength shown in Part B of Table 1.

Results for Fast Tack show that it retains about 60% of its room temperature strength at the higher temperature. Its temperature degradation is similar to Mastik'One's retaining a bond strength of nominally 55%-60% of Mastik'One's across the entire temperature range tested.

Figure 3 presents the adhesives which have the lowest relative strength at the higher operating temperatures. Clement, Wolber and Pana Cement retain 20%, 35% and 50% of their room temperature strength, respectively. Perhaps more importantly, as temperature rises, their strength relative to Mastik'One at the equivalent temperature falls from nominally 80%, 60% and 50% to 25%, 30% and 40%, respectively. These adhesives are more sensitive to temperature than Mastik'One. As part of the measurements, the failure of the adhesive to bond to the rim is measured. In this case, Wolber and Pana Cement fail to bond to the rim. After roll-off only 15% of the rim surface retains any adhesive. Clement's degradation is different. If becomes more fluid leaving adhesive on the rim but this does not appear to be due to bonding. It appears to be due to the liquid-like nature of the adhesive.

Conclusions

Note that 60 ^oC (140 ^oF) is extreme and is not likely to be experienced often. These adhesives have all been proven to be effective under extreme racing conditions. Consequently, these results should not be construed as a recommendation against any of them. However, when extreme braking conditions are expected due to the course or the rider's talents or when racing on asphalt in extremely hot conditions is expected, these measurements do show that some of the popular adhesives do withstand high operating temperatures better than others. These adhesives will have less likelihood of failure (roll-off) and creep.

It's the mechanics' responsibility to be aware of the operating limitations of the equipment. To this point in the article series, information on gluing procedure, tire installation, glue type, curing times and temperatures of operation have been provided so that mechanics can select and use adhesives which will provide the safest equipment for the rider.

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Citations

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