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Improving equine welfare: high performance adhesive films for fast and reusable horseshoe attachment

CMC Ferreira (INEGI, Portugal)| BD Simões | EAS Marques | RJC Carbas | LFM da Silva

Introduction

Traditional horseshoeing relies on nailing the shoe to the hoof, which can damage the hoof wall, increase the risk of infection, and makes removal physically demanding. Glue-on systems offer alternatives, but commercial paste adhesives often overflow during application, generating waste. They require significant time to reach full strength, restricting the horse's mobility, and lack a debonding-on-demand mechanism making it challenging. To overcome these limitations, an epoxy-based thermoplastic film adhesive (T-Link® from L&L Products®, USA) is proposed here by studying its mechanical performance, debonding response, and adhesive–hoof interaction to evaluate its suitability for glue-on horseshoeing.

Why T-LINK® ?

Easy handling | 1 – 15 min | 140 – 176°C | High adhesion | Debonding-on-demand

Experimental testing

Lap shear performance of the proposed adhesive and debonding behavior

Aluminum SLJ were manufactured under 1 minute with a hot air gun and then tested at 1 mm/min. Comparing the mechanical performance of the candidate to that of a commercial horseshoeing glue, despite a 17% increase in the peak load, both adhesives showed similar energy absorption which highlights the potential of T-Link® for glue-on horseshoeing.

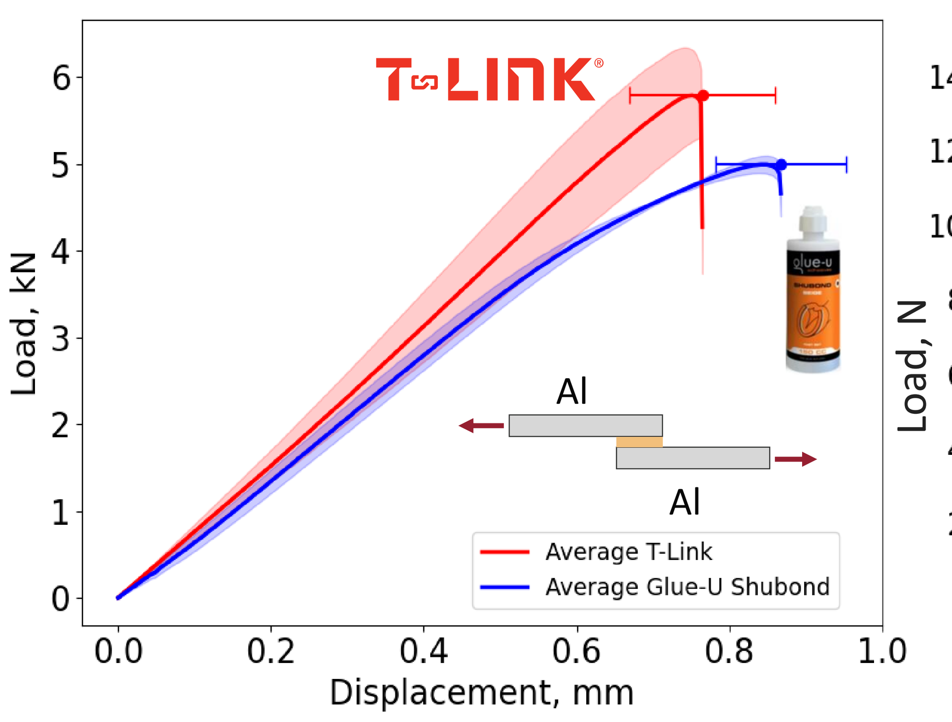

Figure 1: Comparison of quasi-static SLJ responses.

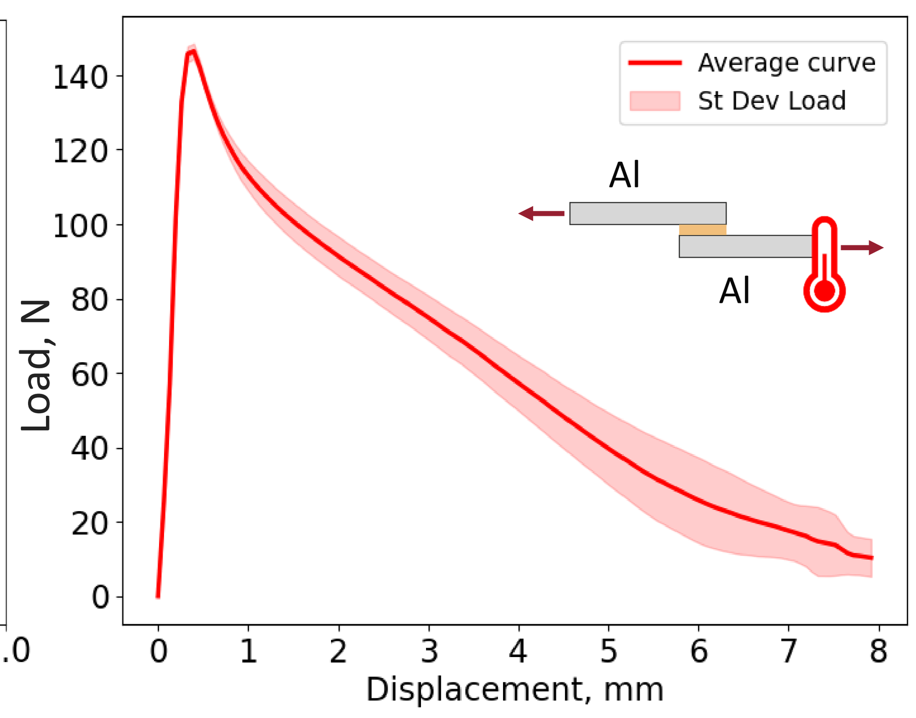

Figure 2: SLJ testing at debonding speeds.

The dismantling behavior was assessed by pre-heating SLJ and when the adhesive layer indicated 150°C, the test was initiated at a debonding speed of 200 mm/min. As evidenced by Fig.2, the residual strength was approximately 2% of the static one (from Fig.1) and although not directly comparable, this already shows how easily the adhesive can be dismantled.

Hoof microstructural effects on adhesion

SEM analysis

SEM analysis of a hoof sample revealed a hierarchical hoof wall structure with hollow tubules embedded in a keratin-rich intertubular matrix. The combination of a fibrillar lamellar organization and layered tubule walls contributes to crack deflection and improved fracture toughness and enhances adhesive bonding due to mechanical interlocking promoted by a rough surface topography.

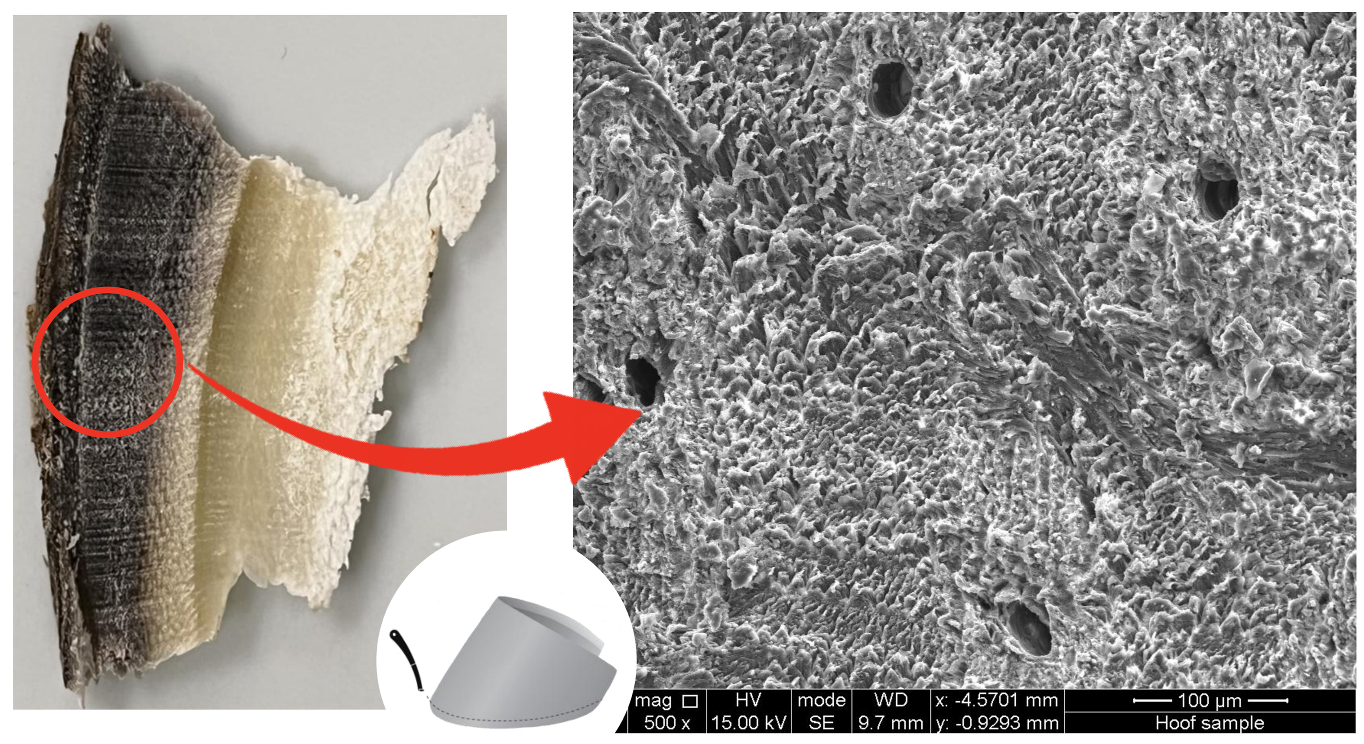

Figure 3: SEM of a hoof pairing sample (parallel to the bonding plane) showing the cross-section of multiple keratin tubules.

Adhesive infiltration study

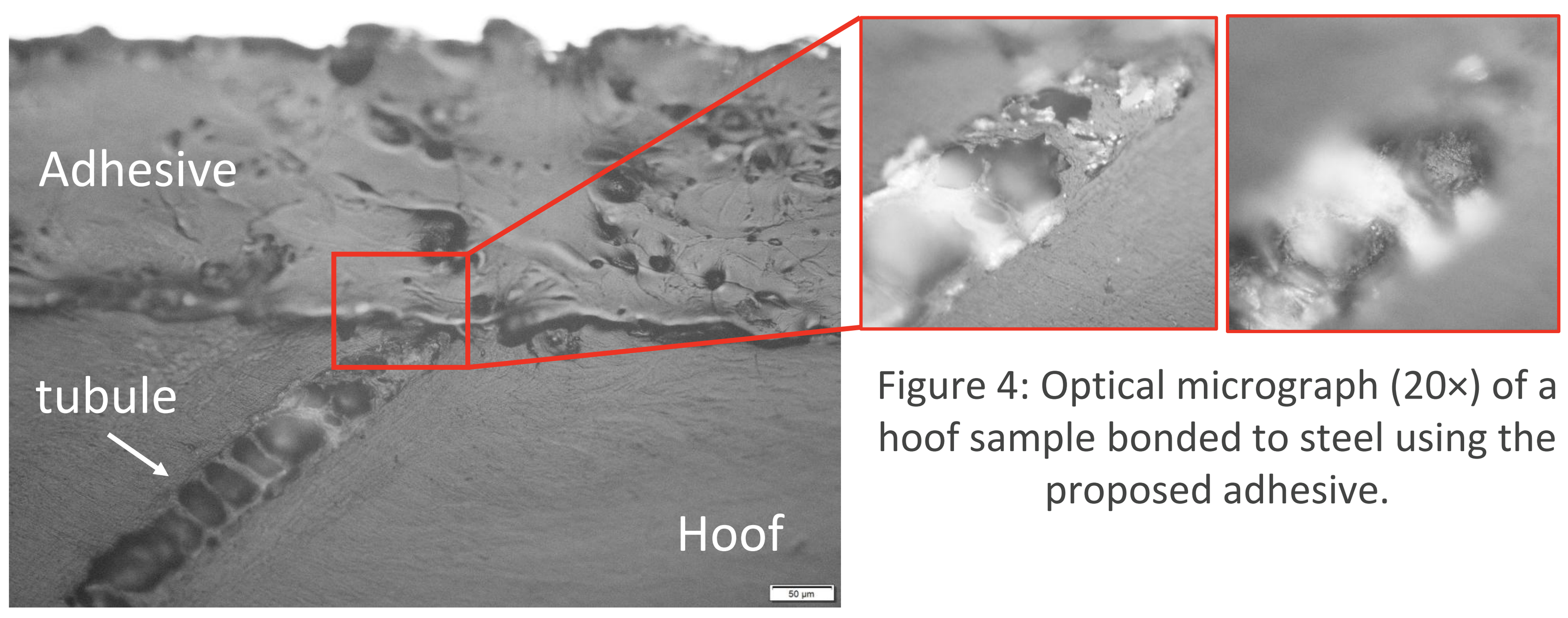

Figure 4: Optical micrograph (20×) of a hoof sample bonded to steel using the proposed adhesive.

Higher-magnification images at two focal depths were taken at the tubule region to assess adhesive penetration. The observations confirmed that the tubules remained hollow after bonding

Conclusions

T-Link® showed lap shear performance comparable to a commercial glue plus easy dismantling. Hoof adhesion relies on surface roughness-induced mechanical interlocking, with no tubule infiltration causing no bondline starvation. Required adhesive thickness will only depend on substrate roughness and hoof–horseshoe non-parallelism.

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