TECHNOLOGY DIGEST
TD-17-024
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Recommended End Hose Gladhand Wear Dimensions

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Summary

Transportation Technology Center, Inc. (TTCI) tested 12 straight shank end hoses to demonstrate the effects of altering the gladhand lip bead dimensions on the force required to separate the end hoses. Test results demonstrated that a lip bead height greater than 0.05 inch covering at least 50 percent of the original lip bead arc length has statistically larger separation forces compared to gladhands with more wear. Based on these tests, TTCI is recommending that lip bead height be maintained to a dimension greater than 0.05 inch covering at least 50 percent of the original lip bead arc length. The suggested limits provide a standard that is easy to implement in revenue service. These limits are well beyond the range of normal gladhand wear while still maintaining separation forces comparable to those produced by new end hoses. This criterion will limit potential removals to cases of extreme wear. A simple go/no-go prototype gauge to test worn gladhand dimensions against these values was designed and produced. End hoses cannot currently be condemned for gladhand wear under the *Field Manual of the AAR Interchange Rules*.

Twelve new gladhands were machined to simulate lip bead height wear, arc length wear, and a combination of both. These gladhands were then tested to determine the median separation force for various pairs of end hoses over several iterations of machining.

This investigation was undertaken by TTCI as part of the AAR Strategic Research Initiative on Improved Performance of Brake Systems. The data was acquired during testing conducted in the air brake laboratory at the Transportation Technology Center (TTC).

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INTRODUCTION

TTCI has been investigating the effect of gladhand dimensions on the force required to separate end hoses. Based on recent test results, TTCI has proposed wear limits for the lip bead of the gladhand and has designed and produced a prototype go/no-go gauge for determining if a gladhand has exceeded these wear limits. Previous research suggested a proportional relationship exists between the height of the lip bead and the gladhand separation force.[1] Recent tests explored this relationship further by incrementally altering the lip bead height and arc length on new gladhands. Based on data taken from different combinations of 12 straight shank end hoses, a statistical reduction in separation force occurs when the lip bead height is reduced to 0.05 inch or less and/or more than 50 percent of the lip bead arc length is removed completely. Figure 1 displays the location of the lip bead on the gladhand.

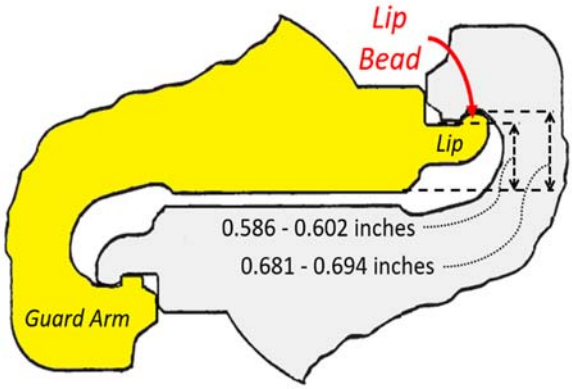

Figure 1. Gladhand Component Diagram

BACKGROUND

The *Field Manual of the AAR Interchange Rules* does not currently allow for condemning of end hoses due to wear.[2] Although gladhand wear has not been shown to be a major root cause of air hose separations, extreme wear does result in low separation forces. A previous investigation by TTCI demonstrated that the median separation force for a pair of end hoses with both gladhand lip beads worn off was quite low: 63 lbf with worn gaskets and 92 lbf with new wide lip gaskets.[1] This previous study also showed that wear experienced by gladhands is sporadic and uneven along the arc length of the lip bead.

TEST DETAILS

TTCI performed the test using an end hose separation test machine donated by the Union Pacific Railroad. A set of two end hoses are attached to the machine and then coupled together. A hydraulic cylinder then moves them apart until separation occurs. TTCI contributed a source of compressed air for the coupled end hoses and a force measuring load pin to collect the maximum tensile force data between the hoses prior to separation. Figure 2 shows the end hose separation force test machine.

Figure 2. End Hose Separation Force Test Machine

The test procedure was designed to record the median separation force for various pairs of end hoses over several iterations of machining. Machining of the lip bead height and the arc length was performed to simulate different stages of wear that a gladhand could experience over time. Figure 3 shows examples of machined lip beads.

Figure 3. Machined Lip Bead Arc Length (Left) and Lip Bead Height (Right)

A test matrix was created to look at the independent and combined effects of lip bead height and arc length dimensions on separation force. The following end hoses were tested:

- 4 end hoses with machined lip bead height
- 4 end hoses with machined lip bead arc length
- 4 end hoses with machined lip bead height and arc length

All end hose combinations were tested within each group, followed by a machining process of the gladhands. This procedure was repeated until the gladhands were machined to the desired final dimensions and the last set of testing was performed.

Each of the 12 straight shank end hoses were provided by a single supplier and were outfitted with new wide lip gaskets for each set of runs. During testing of each pair of end hoses, 30 separation events were recorded. The first 10 events were considered the break-in period for the gaskets, and only the final 20 events were used in generating the median separation force. The hoses were pressurized to 90 psi prior to each separation.

RESULTS

The test matrix produced a total of 66 sets of runs, and three machining processes were completed on each category of end hoses. The resulting median separation force data was analyzed by looking at the lip bead dimensions independently for each end hose and in combination with the pair of end hoses to test for a correlation between these parameters.

The strongest correlation found by the analysis was seen when comparing both lip bead height and arc length in conjunction with the separation force in a contour plot. The resulting plot was then split into quadrants to test for statistical differences in the data. The values of 0.05 inch and 50 percent were selected to produce standard limits that are understandable and simple to implement. Figure 4 displays the plot and Table 1 lists the quadrant details used to categorize the data.

The upper right hand corner of Quadrant 2 represents the dimensions associated with new end hoses. As the hoses wear, they move toward the other quadrants as illustrated in Figure 4. A Mood median test was performed on the quadrants and it demonstrates that Quadrant 2, with a lip bead height greater than 0.05 inch and an arc length of at least 50 percent, has statistically larger separation forces compared to the other quadrants. Figure 5 shows the mood median hypothesis test results.

Wear limits of 0.05 inch for lip bead height and 50 percent for lip bead arc are proposed. These proposed limits are outside the range of values for normal wear of gladhands before removal from service.[1] This will limit the number of gladhands that fail a criterion based on this proposal and will only remove cases of extreme wear from revenue service.

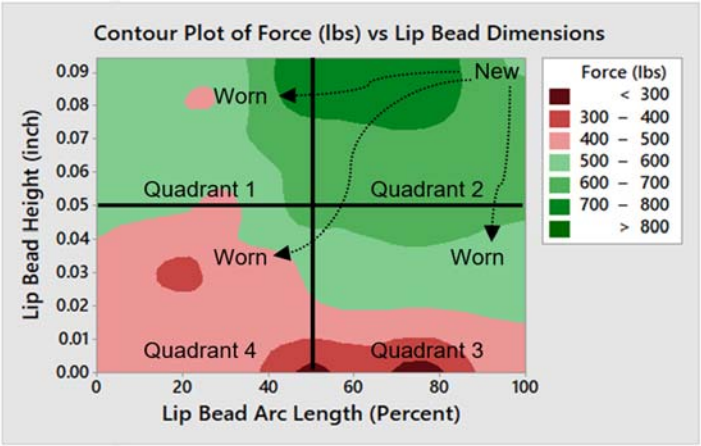

Figure 4. Contour Plot of Separation Force vs Lip Bead Dimensions

Table 1. Quadrant Statistics

Quadrant	Lip Bead Height (in)	Lip Bead Arc Length (%)	Median Separation Force (lbf)
1	> 0.05	< 50	488
2	> 0.05	≥ 50	665
3	≤ 0.05	≥ 50	567
4	≤ 0.05	< 50	454

Mood Median Test: Median Force (lbs) versus Quadrant

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Mood median test for Median Force (lbs)
Chi-Square = 35.49    DF = 3    P = 0.000

                                  Individual 95.0% CIs
Quadrant  N≤  N>  Median  Q3-Q1  ----+---------+---------+---------+--
1          5   1     488   145   (------------*-----------)
2          5  29     665   181                            (---*---)
3         12   5     567   143                   (---*-------)
4         13   0     454   119   (-------*--)
                                 ----+---------+---------+---------+--
                                   400       500       600       700

Overall median = 588
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Figure 5. Mood Median Hypothesis Test Results

GAUGE DESIGN

Although dimensional standards exist for new gladhands,[3] there are not currently any quantifiable dimensional specifications for worn gladhands. The gladhand testing demonstrated a significant difference in separation force based on lip bead height and arc length. TTCI designed and produced a prototype go/no-go gauge using the results of the gladhand testing and the statistical analysis. The design was created to be a flat, lightweight instrument that can be carried by a carman. The gauge is utilized to validate the height of the lip bead at various points along the arc of the gladhand. Figure 6 shows the prototype gauge.

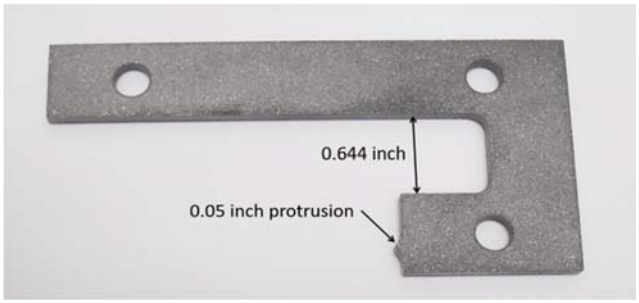

Figure 6. Prototype Lip Bead Go/No-Go Gauge

The gauge uses the flat machined surface of the gladhand coupling face as a reference to check the lip bead's relative height. The proposed wear limit dimension of the gauge is 0.644 inch and it is intended to fail a gladhand originally produced at the mid-point between allowable manufacturing tolerances with a lip bead that has worn to a height less than 0.05 inch. If the gauge can be seated flat on the coupling face and slip over the lip bead, then the gladhand fails the proposed wear limits and should be removed from service. A gladhand that contains a lip bead with sufficient height will not permit the gauge to slide over the lip bead. Figure 7 shows an example of a failed and successful lip bead height check.

Figure 7. (left) Passed Lip Bead Height Check and (right) Failed Lip Bead Height Check

The go/no-go gauge is designed with a raised protrusion on the end of the instrument that is 0.05 inch in height (Figure 6). This protrusion is used to verify the lip bead height. By inverting the gauge, the protrusion, along with its surrounding planar surface, will interface with the lip bead and fit into the groove directly behind it. If the protrusion is touching the flat, grooved area, then the lip bead does not meet the height requirement. This procedure is shown in Figure 8.

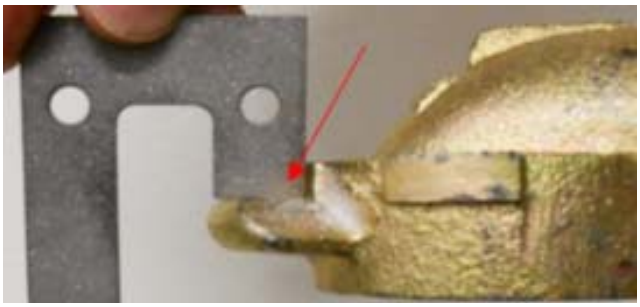

Figure 8. Passed Height Check with Inverted Gauge

CONCLUSION

TTCI has analyzed the relationship between gladhand lip bead dimensions and separation forces of 12 new end hoses with wide lip gaskets through an iterative machining process of the lip bead. Test results demonstrated that a lip bead height greater than 0.05 inch covering at least 50 percent of the original lip bead arc length has statistically larger separation forces compared to gladhands with more wear.

Thus, TTCI is proposing these dimensions as wear limits for glad hands. TTCI designed and produced a simple prototype go/no-go gauge to test worn gladhand dimensions against these values. TTCI has presented these findings to the AAR Brake Systems Committee for consideration.

REFERENCES

1. Cummings, Scott, Chad Sexton, and Edwin Satre. October 2016. "End Hose Gladhand Dimensions and Separation Forces." *Technology Digest* TD-16-042. AAR/TTCI, Pueblo, CO.
2. Association of American Railroads. 2017. *Field Manual of the AAR Interchange Rules*. Washington, D.C.
3. Association of American Railroads. Last Revised 2002. *AAR Manual of Standards and Recommended Practices*. Section E. Standard S-456. "Hose Coupling Gauges for Gauging New and Used Couplings." Washington, D.C.