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Brake Shoe Shape to Reduce the Incidence of Asymmetric Wheel Wear, Overhanging Brake Shoes, and High Contact Conicity

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Summary

An alternative brake shoe shape is proposed to reduce the incidence of asymmetric wheel flange wear and overhanging brake shoes as well as reduce the incidence of high contact conicities, which lead to vehicle instability. It is proposed that this brake shoe:

- Be asymmetrically shaped with more material adjacent to the wheel flange and a profile matching that of the new SRI-1A wheel profile
- Have a reduced (or eliminated) taper toward its ends to reduce the concentration of tread wear toward the longitudinal center line of the shoe and toward the tape line of the tread

Asymmetric wheel tread wear has been associated with asymmetric brake shoe wear.¹ In turn, asymmetric wheel tread wear has been associated with overhanging brake shoes,¹ resulting in heat checks on the field side of the profile. Both asymmetric wheel flange wear and heat checks result in reduced wheel life.

Also, tread wear resulting in high contact conicities has been associated with the action of brake shoes.² These high conicities reduce the hunting stability of both empty and loaded cars; hunting results in accelerated car and track damage. The introduction of increased demands on the car suspension to cope with increased conicities will increase their cost and complexity.

This research is conducted by Transportation Technology Center, Inc. as part of the Association of American Railroads' (AAR) Strategic Research Initiatives Program to improve brake performance, develop an integrated freight truck design, and support the work of the AAR Advanced Technology Safety Initiative.



INTRODUCTION

Asymmetric wheel tread wear has been associated with asymmetric brake shoe wear.¹ In turn, asymmetric wheel tread wear has been associated with overhanging brake shoes.¹ Also, tread wear resulting in high contact conicities has been associated with the action of brake shoes.²

Recommendations are to extend monitoring to verify this association and to take remedial action to improve the brake beam and truck brake rigging and limit the aggressive action of the brake shoe. In-service verification is anticipated to take 1 ½ to 3 ½ years given the mileages of 150,000 to 350,000 miles before degradation is manifested. Laboratory testing of wheel/shoe interaction is likely to be extended. Improving the brake rigging is costly and will take time. Limiting the aggressive action of the brake shoe is likely to be a time-consuming developmental process and counter to the use of tread conditioning shoes to control the incidence of high impact wheels.

Consequently, Transportation Technology Center, Inc. (TTCI) is proposing the use of an alternative brake shoe shape, which is intended to improve the lateral guidance of the shoe and beam and spread the wear due to the shoe more evenly across the wheel tread. This *Technology Digest* describes the nature of the proposed alternative shoe shape and reasons for an anticipated improved performance. The anticipated improved performance is considered a partial solution; improved rigging is still considered necessary; a limit on the aggressiveness of the shoe action may still be necessary. The production of an improved shoe shape will enable in-service monitoring and laboratory testing to run in parallel with proposed verification actions, saving time and money. A speedy indication of the means to control wheel tread wear and achieve anticipated results will enable a more assured application of AAR M-976 and Chapter 11 specifications, which base car performance on anticipated in-service contact conicity.

This research is conducted by TTCI as part of the AAR Strategic Research Initiatives (SRI) Program to improve brake performance, develop an integrated freight truck design, and support the work of the Advanced Technology Safety Initiative.

IMPROVED LATERAL GUIDANCE OF BRAKE SHOE AND BEAM

Asymmetric wheel tread wear is associated with the lateral migration of the brake shoes and beam across the tread. This migration can occur as a result of the local wear of the shoe in the region of the flange fillet of the wheel as well as in the lateral clearance, δ , between shoe and flange (Figure 1).

Lateral wear of the corner of the brake shoe, relief of the shoe profile to better fit the wheel profile, and the use of thinner shoes will increase the effective lateral clearance between shoe and flange. This clearance equals the amount that the shoe can migrate laterally across the wheel tread while not considering the additional clearance resulting from wheel flange wear, as Figure 2 shows.

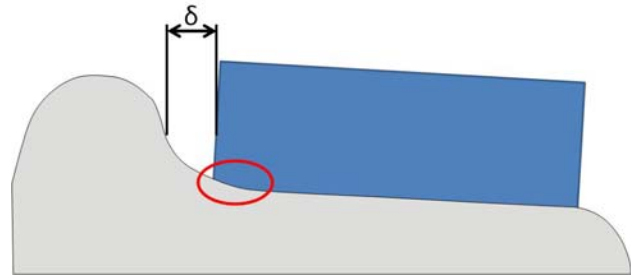


Figure 1. Central Position of the Brake Shoe on the Wheel Tread

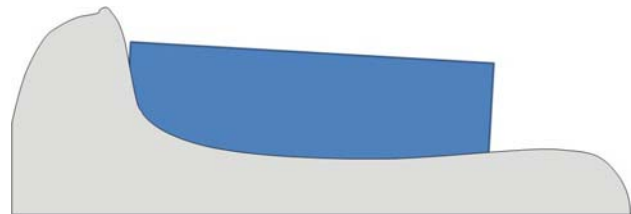


Figure 2. Lateral Migration of the Flanging Shoe due to the Combined Lateral Clearance, δ , and Flange Wear

Figure 3 shows the resulting migration of the overhanging brake shoe. The consequence of an overhanging brake shoe includes the formation of heat checks on the field side of the wheel tread.

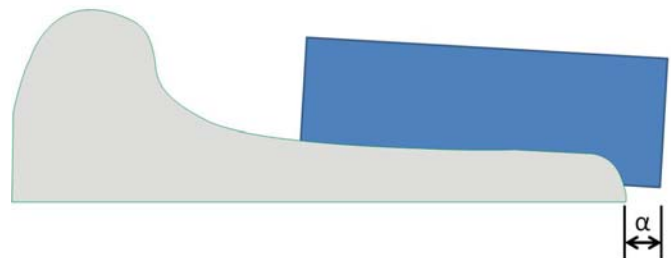


Figure 3. Lateral Migration of the Overhanging Brake Shoe due to the Combined Lateral Clearance, δ , and Flange Wear

TTCI proposes that the brake shoe be extended toward the wheel flange by a distance, δ , and profiled to fit the wheel tread; Figure 4 shows the nature of this extension.

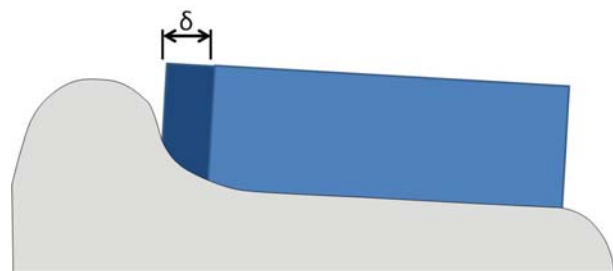


Figure 4. Width and Profile of the Proposed Extension to the Brake Shoe

Inspection of the amount of overhang, α , observed in service (Figure 3) suggests that it is approximately equal to the clearance, δ , between shoe and flange with the beam centralized laterally on the wheelset (Figure 4). A comprehensive study of the tolerances of wheelset, beam, and brake shoe is required to determine the optimum value for δ :

- It is possible that the effective width of the modified shoe must be altered toward the field side to ensure that with maximum wheel flange wear, the shoe will not overhang the wheel.
- The pitch between the inner faces of the shoes determined by the beam/shoe assembly must always be greater than that between the flange faces.

The profile of the tread should match that of the SRI-1A profile currently in development; this profile matches that of the worn wheel tread in the region of the flange.

Care will have to be taken to limit the height of shoe/flange contact (Figure 5). The higher the contact on the flange, the larger the “wedging” action of the shoe and beam on the wheelset. This may result in increased flange temperatures and accelerated flange wear if the contact is too high on the flange and the length of the beam/shoe combination too tight on the wheelset with a combination of maximum width flanges and prevailing tread wear.

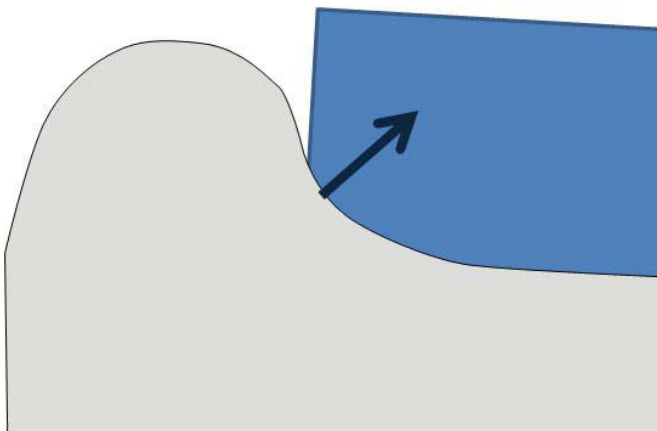


Figure 5. Possible Wedging Action of the Shoe against the Wheel Flange if Shoe/Flange Contact is Too High on the Flange and the Beam/Shoe Combination “Pinches” against the Flanges of the Wheel Treads

SPREADING SHOE WEAR MORE EVENLY ACROSS THE WHEEL TREAD TO REDUCE CONTACT CONICITY

The increased effective width of the brake shoe combined with contact in the flange fillet should “spread” the wear attributable to the brake shoe and reduce the contact conicity during the service life of the wheel profile.² Even tread wear will be facilitated if the tread wear edge effects observed during the AAR acceptance tests are reduced.² Figure 6 repeats these results.

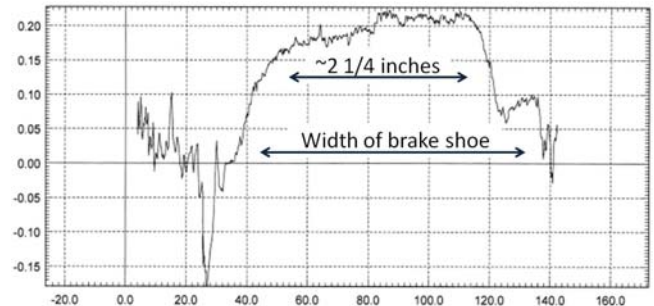


Figure 6. Tread Wear Produced by a Shoe during the AAR Certification Test

Interestingly, the region of maximum tread wear is less than the width of the brake shoe. Examination of the shape of the shoe producing this wear shows that the shoe is tapered toward its ends (Figure 7).

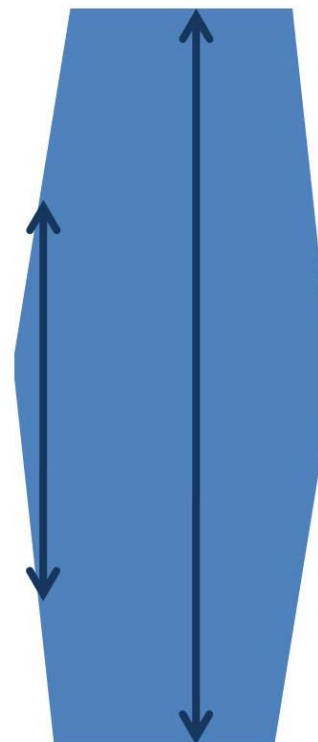


Figure 7. Contact Shape between Shoe and Wheel Tread

Consequently, the rubbing distance of the wheel on the tread is longer toward the longitudinal centerline of the shoe than toward the edges, which is possibly the reason for the edge effects observed.

Care should be taken with the interpretation of the tread wear results in Figure 6. This wear was measured on a brake dynamometer in the laboratory. No wheel/rail contact was made to work harden the wheel tread and the tread was probably softened through heating. This may distort the results from those experienced in revenue service.

CONCLUSIONS

An alternative brake shoe shape is proposed to reduce the incidence of asymmetric wheel flange wear and overhanging brake shoes and to reduce the incidence of high contact conicities. It is proposed that this shoe:

- Be asymmetrically shaped with more material adjacent to the wheel flange and have a profile matching that of the SRI-1A wheel profile
- Have a reduced (or eliminated) taper toward its ends to reduce the concentration of tread wear toward the longitudinal centerline of the shoe and toward the tape line of the tread

Also, it is proposed that in the design process, the effects of both hardening of the tread surface and wear, as a result of contact with the rail, be taken into account.

An asymmetrically shaped brake shoe does not necessarily imply increased maintenance issues:

- The shoe orientation is reversed about a horizontal axis by the carman for diagonally opposing brake shoe positions; consequently, the field side face of the shoe (as opposed to that face contacting the flange) always faces the field side of the car.
- The field side face of the brake shoe can be painted another color so that the orientation of the shoe may be easily seen by inspectors and by the carman replacing it.
- The brake shoe asymmetry should be sufficient to make incorrect application more difficult than correct application.

REFERENCES

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2. Tournay, Harry M. October 2010. "Possible Root Cause for High Conicity Wheel Profiles on Grain Cars Associated with Loaded Car Hunting," *Technology Digest* TD-10-037, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, Colo.

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