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Study on the influence of groove parameters on the anti-sliding performance of cement concrete runway

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Abstract. The anti-sliding performance of cement concrete runway in airport is studied by means of different groove parameters. The results show that groove direction, slot spacing, groove width, groove section and groove depth can influence the anti-sliding performance of the runway.

1. Introduction

Due to the good durability and low maintenance cost of cement concrete itself, most airports in China currently use cement concrete runway., with the rapid development of civil aviation, the use of aircraft and aircraft take-off weight landing speed also increased significantly, the surface of the runway performance especially the anti-sliding performance in terms of security and accelerate the plane landed safely braking is becoming more and more attention, Good runway surface friction is an important guarantee to prevent skidding and getting out of control when the aircraft is braking, In this paper, the influence of groove parameters on the anti-sliding of cement concrete runway is analyzed.

2. Groove direction

2.1 Longitudinal grooves

The longitudinal grooves are continuous, and the horizontal is discontinuous. When longitudinal force is applied on the tire, the longitudinal groove is subjected to the opposite direction of the small horizontal force, the tread of the tire tread is very small; The longitudinal grooves on the runway surface are equivalent to a number of small cantilever beams, resulting in a large transverse reaction force, which prevents the tire from sliding sideways. Therefore, the friction between the tire and the longitudinal groove will be mainly tilted to the horizontal when the longitudinal force and transverse force are applied on the tire, that is, the longitudinal groove has good horizontal anti-slip ability. In some cases (emergency brake braking), the furrow effect is still present in the longitudinal groove, resulting in friction, which can shorten the braking distance and ensure the safety of driving. Furrows effect is a phenomenon of Metal tribology, refers to that the rough peak of hard metal is embedded in soft metal, and the soft metal is extruded in the sliding, so that the plastic flow and the plough are made out of a groove, which creates certain resistance in the process, as shown in figure 1.

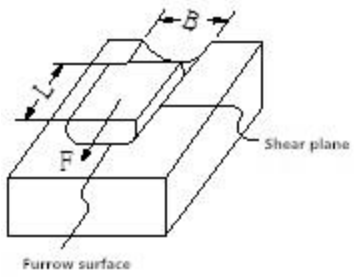


Figure 1 the friction model of adhesion effect and furrow effect

In emergency brake situation, assume that the cement concrete runway surface longitudinal grooving for hard metal, tire and rubber for soft metal, due to the deformation of vehicle tire rubber, will be embedded in the tire rubber internal longitudinal grooving, push in and slide along the vehicle tire rubber, and plough out a groove, the resistance generated in this process becomes an important component of the anti-slip force of the longitudinal groove runway. At the same time, longitudinal grooved road surface can improve the direction control and reduce the accident very effectively.

2.2 Transverse groove

In contrast to the longitudinal grooves, the transverse groove is continuous on the horizontal and the longitudinal is divided by a certain distance (groove spacing). When the tire is rolling on the transverse groove, a repeat periodic collision between the tire and the transverse groove will occur, resulting in the transformation of the tire rubber deformation energy loss into a part of the friction force. At the same time, when the tire has vertical force and lateral force, the friction force between the tire and the runway surface will be mainly in the longitudinal direction, that is, the transverse groove has better longitudinal anti-slip ability. Because of the existence of the transverse slope, the transverse groove can be well used to assist the drainage.

2.3 Oblique grooves

For oblique groove, The lateral and vertical forces of the road surface are generated by the lateral and longitudinal forces of the tire, It has a good effect on the bend section, and when used in general road section, it is easy to slip out of the vehicle.

3. Groove spacing

Groove spacing, the smaller the unit length within the scope of the groove number, the more the actual contact area of tire and runway surface is smaller, the same tire pressure and under the vehicle load, the contact pressure, the greater the tire/pavement unit between tire and road surface adhesion, surface friction performance is good. In certain cases, the groove depth groove spacing is smaller, will increase the rainy cases road surface drainage channel, to speed up the water discharge, can better reduce water skiing, guarantee the contact between the tire/pavement.

If the groove spacing is too small, under certain horizontal force, especially when the vehicle is braking, the shear stress of the slot is increased, the durability is not good, and it is easy to be damaged. At the same time, the pressure increase of the tire/channel contact part will increase the tire wear. Construction can also be difficult. The spacing between the grooves will also cause trouble for the construction and reduce the construction efficiency.

4. Groove width

When other groove parameters constant, increase the groove width can assist pavement drainage system to improve drainage ability, make water between tires and the runway surface to rule out as soon as possible, keep tire and road surface contact state, thus effectively prevent or reduce the

possibility of rain cases appeared hydroplaning. It can also reduce or avoid the phenomenon of water mist, which affects the driving view of motorists.

In addition, simply increasing the width of the groove means that the net spacing of the groove is reduced, the actual contact area of the tire and runway surface is reduced, the unit contact pressure increases, and the adhesion of the tire and the runway surface is improved. at the same time, the tire deformation, embedded into the inside of the groove area increases, embedded depth increase (especially for the longitudinal groove), and also to improve the friction between the surface and the tires.

Relevant studies show that the transverse force coefficient (SFC) increases with the width of the groove while the groove width is 20mm, but the groove width exceeds 5mm and presents the descending trend which is shown in FIG. 2.

Of course, when the groove spacing is constant, the groove width is increased, the spacing of the groove is smaller, the car brake is easy to damage, and the durability is not good. At the same time, it can aggravate tire wear. The width of the groove will also have a negative effect on the flatness of the runway surface.

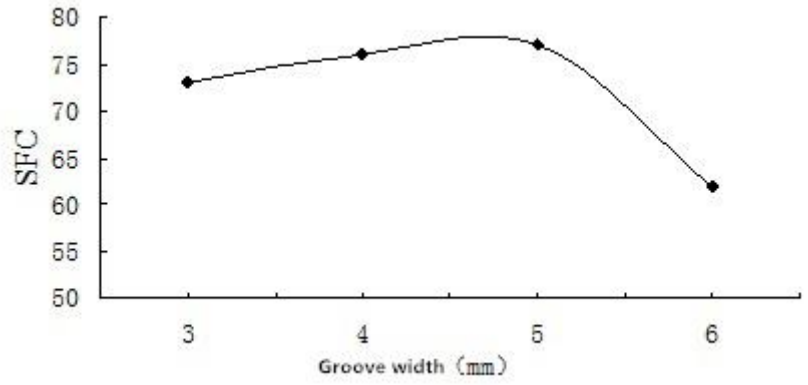
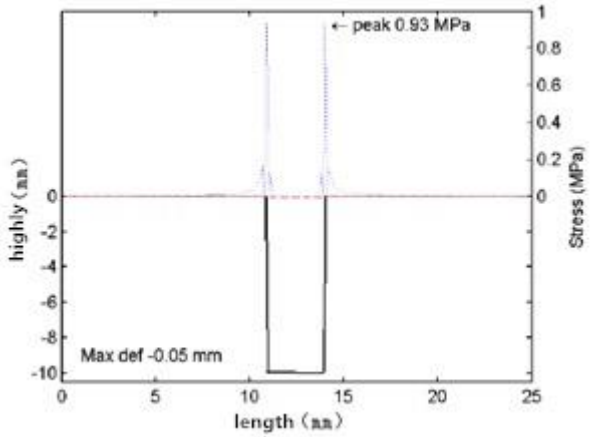


Figure. 2 relation curve of SFC and groove width (20mm between groove center)

5. Groove section

In the rolling process of the tire, there is a repeated collision between the grooves and tire , and the joint effect of the tire impact load and the vertical load on the corner of the groove can produce stress concentration. The stress concentration of trapezoid groove is obviously better than that of rectangular groove. The research shows that when the same load is applied, the groove width is 3mm, the groove is 5mm deep, and the peak stress of the corner of the rectangular section is 0.93 Mpa, while the trapezoidal section groove is 0.20 Mpa, as shown in FIG. 3.



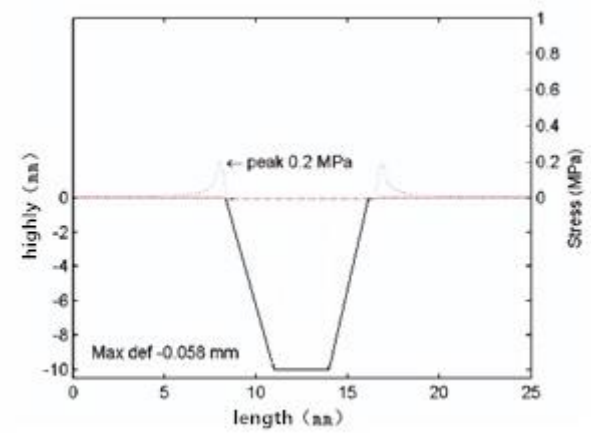


Figure. 3 comparison of stress concentration peak stress in rectangular groove and trapezoidal groove stress concentration

In addition, the trapezoid groove can diffuse the frost swelling force very well when the surface freezes, thus avoiding the damage caused by the freezing swelling force.

From between the tire and groove embedded depth, the contact area, trapezoidal channel, tire deformation is embedded into the depth of the groove, and the tank wall part contact area increase, provides the friction of the larger than the rectangular groove, especially for the longitudinal grooving on this point.

6. Groove depth

The influence of groove depth on the anti-slip performance is mainly reflected in the surface drainage and durability. In the case of groove width and groove spacing, the larger the depth of the groove and the larger the depth of the surface structure, the high water discharge efficiency and avoid the phenomenon of water skiing and water mist. In the same road surface materials and construction conditions, the larger the groove, the longer the corresponding grinding consumption years, the longer the resistance of the road surface anti-slip performance.

7. Conclusion

When other groove parameters are invariant, the spacing of the groove is reduced or the groove width increases, the drainage efficiency is improved in rainy days, the water slide is weakened, and the pressure of tire/pavement interface is increased, and the anti-slip performance is improved. The trapezoidal section has a better stress condition than the rectangular section, and the stress concentration of the corners is weak, and the deformation of the tire embedded in the groove is good for anti-skid. At the same rate of abrasion, the larger the groove depth, the longer the groove structure life, but the groove is too deep to cause construction difficulties.

Reference

[1] Cackler, E.T., Concrete Pavement Surface Characteristics: Evaluation of Current Methods for Controlling Tire-Pavement Noise, Final Report of FHWA Cooperative Agreement DTFH61-01-X-00042, Project 15, 2006.

[2] David A. Kuemmel, Ronald C. Sontag, James A Crovetti, Yosef Becker,John R Jaeckel, Allex Satanovsky, Noise and Texture on PCC Pavements, Results of a Multi-state Study, 2000,5;

[3] P. R. Donavan and L. Scofield, An Evaluation of the Effects of Different Portland Cement Concrete Pavement Texturing on Tire/pavement Noise, Proceedings of Noise-Con 2003 Cleveland, Ohio 2003.

[4] G R Watts, P M Nelson, P G Abbott. Tire/road noise – Assessment of the existing and proposed tire noise limits. PUBLISHED PROJECT REPORT PPR 077,2006;