Wave Emission From Screw Holes During Heavy-Duty Seamless Lot Flaw Detection by a Large Flaw Detection Vehicle Study on Water Wedge Effect with Probe Wheel

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Abstract: This paper describes the large flaw detection vehicle in the heavy load seamless lot for flaw detection when the screw hole wave loss and the reasons for the water wedge effect of the probe wheel, in order to study the impact mechanism between such wave loss and the water wedge effect, respectively, the coupling water thickness, under pressure, tire pressure and sensitivity parameters and other four factors, the probe wheel water wedge effect performance of the test and dynamic verification. The results show that: the amount of pressure, tire pressure increases, the critical water sliding speed of the probe wheel with the increase, the less likely to lose the wave of the screw hole; with the coupling water thickness increases, the tire critical water sliding speed decreases, the more likely to lose the wave of the screw hole; and in reaching the critical water sliding speed, adjust the sensitivity to lose the effectiveness of the wave of the screw hole. To explore the influence of various factors on the effect of the water wedge of the flaw detection, to provide reference for the application of flaw detection.

Keywords: Screw Hole Wave; Loss of Wave; Water Wedge Effect; Critical Water Sliding Speed

1. Research background and significance

When a large flaw detection vehicle operates in a seamless lot, it is impossible to observe the joint wave out, and whether the screw hole wave out is complete becomes one of the important bases for judging the quality of detection. At the same time, the probe wheel is the only effective part of the direct contact between the ultrasonic wave and the rail, playing an important role in conducting and receiving the ultrasonic wave signal, whether the good running state of the probe wheel determines the quality of the ultrasonic wave into the internal rail flaw detection. And in the operation process of straight line lot because the rail surface is more smooth and smooth, from time to time there will be 45° screw hole out of the wave incomplete phenomenon, affecting the accuracy of the inspector to adjust the sensitivity. Therefore, the running state of the probe wheel or not will seriously affect the quality of flaw detection operations.

2. Analysis of the wave out of the screw hole

In the operation process of the flaw detection vehicle, due to coupling water continues to open, the probe wheel surface and the rail between the water film thickness increases, when the probe wheel speed is low, under the action of fluid dynamic pressure, the friction coefficient between the probe wheel surface and the rail decreases significantly, the probe wheel and the rail part out of contact, thus forming a water wedge. When the wheel speed exceeds a limit speed, the water wedge completely cover the contact surface, so that the probe wheel surface and the rail completely out of contact, known as "complete water slide phenomenon", resulting in the probe wheel and the rail completely lose contact, directly lead to the ultrasonic wave can not enter the rail caused by the rail waist screw hole out of the phenomenon of incomplete.

3. Probe wheel water wedge effect analysis

When the probe wheel and coupling water film just contact, probe wheel has not squeezed the water film, probe wheel full contact with the rail; when the probe wheel continues forward, probe wheel began to squeeze the water film, probe wheel and water film are deformed, resulting in water wedge caused by the probe wheel rail surface adhesion coefficient decline, at this time in the probe wheel and rail contact area there is part of the water flow, the water film can also play a coupling role; if the speed continues to increase, the water flow between the probe wheel and the rail Too much, coupled water movement generated dynamic pressure on the surface of the probe wheel, when the speed reaches the critical speed of water sliding, dynamic water pressure is equal to the amount of pressure under the probe wheel, at this time the probe wheel completely out of the rail surface, floating in the coupled water film above, the probe wheel occurred completely water sliding phenomenon.

4. Screw hole out of the wave situation and the water wedge effect of the probe wheel impact factor analysis

Coupling water thickness, the amount of pressure, tire pressure and sensitivity parameters and other four factors as control variables, to gauge range characterization of tire pressure, the sound range in the wheel characterization of the amount of pressure, the locomotive's operating speed (when the loss of wave screw hole) is determined as the critical water sliding speed of the probe wheel, to characterize the performance of the water wedge effect. To investigate the trend between each factor and the critical water-slide speed of the probe wheel, and then analyze the influence of the water wedge effect on the wave out of the screw hole in depth. (Note: the amount of down pressure is negatively correlated with the sound range in the wheel, Tire pressure filling gauge: 08C1660)

Table 1 shows the test results of critical water sliding velocity of the probe wheel under different working conditions with multiple data sets.

量规量程/mm	轮内声程/μs	耦合水厚度/mm	45° 灵敏度参数/DB	探轮临界滑水速度/KM•h-1
235	92	0.9	36	76
		1.2		68
		1.5		62
		1.8		59
		2.1		55
235	88	1.5	36	69
	90			65
	92			62
	94			60
	96			58
230	92	1.5	36	56
232				58
235				62
237				67
239				70
235	92	1.5	32	62
			34	62
			36	62
			40	62
			44	62

Table 1 The influence of factors on the critical slickwater velocity of the probe wheel

4.1 The influence of coupling water film thickness on the critical slickwater speed of the probe wheel

Different coupling water thickness conditions (Table 1), the probe wheel critical slick water speed trend: the critical slick water speed of the probe wheel are increased with the water film thickness and decreased, this is because when the water film thickness on the rail increases, the water between the probe wheel and the rail increases, with the deformation of the probe wheel, coupling water can not be discharged in time, the water flow will produce dynamic water pressure on the probe wheel, so that the ground attachment coefficient of the probe wheel is reduced. Therefore, the greater the thickness of the water film, the more likely to cause the probe wheel rail waist screw hole out of the wave incomplete, so you can change the coupling water film thickness, so that the ultrasonic wave completely into the internal rail, improve the quality of 45° wafer out of the wave.

4.2 probe wheel under pressure (wheel sound range) on the probe wheel critical slick water speed effect

Different wheel sound range working conditions (Table 1), the probe wheel critical slick water speed trend: the probe wheel critical slick water speed with the increase in the wheel sound range is a decreasing trend, due to the increase in the probe wheel under pressure, the wheel sound range correspondingly reduced, the probe wheel on the rail surface force becomes larger, can be faster to discharge the water from the tire and the road between, and the dynamic water pressure of the water late to reach the probe wheel load, thus delaying the slick water phenomenon, to ensure that the 45° wafer out of the wave in line with operating standards.

4.3 Probe tire pressure (gauge range) on the impact of the critical water slip velocity of the probe wheel

Different range of working conditions (Table 1), the probe wheel critical water-sliding speed trends: probe wheel critical water-sliding speed will increase with the tire pressure and become larger, this is because with the increase in the probe tire pressure, probe wheel deformation will be reduced when traveling operation, the tire pressure area will become smaller at the same time conducive to the timely and rapid discharge of water. Therefore, in the rainy day operation, we should pay attention to the tire pressure of the probe wheel, to avoid the probe wheel becomes soft, tire pressure is less than the standard tire pressure, so it is known that the appropriate increase in tire pressure can improve the probe wheel 45 ° wafer out of the number of grids.

4.4 Sensitivity parameters on the impact on the critical water slip speed of the probe wheel

Different sensitivity parameters working conditions (Table 1), the critical slickwater speed of the probe wheel changes trend:

Probe wheel critical water slip speed does not change with the increase in sensitivity parameters, due to the continuous increase in the thickness of the water film, when a certain thickness, due to the water wedge effect, between the probe wheel and the rail occurred completely water slip phenomenon, resulting in the ultrasonic wave can not enter the rail inside the folded reflection activities, so that the sensitivity parameters lost the impact on the wave grid.

5. Conclusion

The water wedge effect produced by the probe wheel on the seamless line is analyzed, and the four factors affecting the water-slip phenomenon are selected for experimental analysis, and the following conclusions are drawn.

(1) the greater the thickness of the coupling water film, the smaller the critical slippery water speed of the probe wheel, more likely to cause the loss of wave in the screw hole, so the coupling water thickness should be reduced in time to protect the quality of flaw detection operations.

(2) In the same working condition, appropriately increase the inflation pressure of the probe wheel, the deformation of the tire body is reduced, which is conducive to the discharge of coupling water, and the critical water sliding speed of the probe wheel will increase, weakening the impact of the water wedge effect on the wave.

(3) appropriate to increase the amount of pressure, can weaken the impact of the water wedge effect of the probe wheel, to avoid the probe wheel slippage, improve the quality of rail flaw detection.

(4) due to the influence of the water wedge effect, the probe wheel completely slippery water phenomenon, the ultrasonic wave can not enter the rail, only adjust the sensitivity can not improve the loss of the screw hole wave situation.

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