REPORT OF THE CHIEF OF THE BUREAU OF SAFETY COVERING THE INVESTIGATION OF AN ACCIDENT WHICH OCCURRED ON THE UNION PACIFIC RAILROAD NEAR BELOIT, KANS, ON JANUARY 15, 1918.

SEPTEMBER 16, 1918

To the Commission:

On January 15, 1918, there was a derailment of a passenger train on the Union Pacific Railroad near Beloit, Kans, which resulted in the death of 4 passengers and the injury of 22 passengers and 3 employees After investigation I beg to submit the following report

That part of the Union Pacific Railroad upon which this accident occurred is a single-track line, over which trains are operated by time-table, and train orders transmitted by telegraph, no block system being in use The track is laid with 60-pound steel rails, 30 feet in length, on about 16 ties to the rail, single spiked, without tieplates, rail braces, or ballast, but in good condition

Eastbound passenger train No 132 consisted of 1 combination mail and baggage car, 1 baggage car, and 2 coaches, all of wooden construction, hauled by locomotive 945, and was in charge of Conductor Tozier and Engineman Reed. It left Beloit at 8 25 a m, and was derailed at 8 30 a m at bridge 54 92, 2 5 miles east of Beloit, while running at a speed of 20 or 25 miles an hour

The locomotive, combination car, and baggage car crossed the bridge, the locomotive coming to a stop with its front trucks about 380 feet beyond the initial point of derailment; the combination car was derailed immediately behind the locomotive and tilted toward the left; the baggage car was derailed to the left and lay on its side just behind the combination car Figure 1 is a view of the locomotive, combination car, and baggage car after the derailment Both coaches ran a short distance and then fell off the bridge, and landed on their roofs in the bottom of the creek and were demolished, as shown by figures 2 and 3

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Bridge 54 92 is a wooden trestle, 173 feet in length, having a height of from 8 to 27 feet, and supported by 12 piling bents and 2 bulkhead bents Sixty-pound steel guard rails extend over the bridge and 30 feet beyond each end of the bulkheads At the time of the accident the bridge was undergoing repairs, an excavation having been made at the west end of the bridge for the purpose of installing a new bulkhead bent. A 17-inch pile had been driven there and a 12 by 14 inch cap placed on top, then a 16 by 16 pile block, then a 7½ by 8 inch pine tie, which was not spiked to the rail The structure was in fair condition

Locomotive 945 is of the 4-4-O type, having a weight of 69,300 pounds on drivers, and the total weight of the engine loaded is 107,000 pounds The total weight of engine and tender is 214,100 pounds. It was given a general overhauling about four months before the accident occurred, and the work reports for 30 days prior to the accident showed the wheels to be in good condition

The accident occurred on track that was straight and practically level The weather at the time was clear; there was considerable snow on the ground, and the temperature was about 1° below zero

Engineman Reed stated that repair work on bridge 54 92 had been in progress since November, 1917, and during that time he had seen no slow orders protecting movements over it He said he did not notice any unusual roughness of the track on the bridge, and thought the speed of his train was between 20 and 25 miles an hour at the time it was derailed.

Fireman Blevans stated that he noticed no unusual roughness of the track on the bridge, and the first notice he had of the derailment was the application of the air brakes.

Bridgeman Nixon, who had charge of the repair work on the bridge at the time of the accident, stated that when the piling was sawed off at the west end of the bridge, blocks were placed on top of the piles instead of stringers, and ties were placed on top of the blocks, the ties fitting up against the rails properly

Bridgeman Horr stated that after the blocks were put in place on top of the piling it was necessary to raise the rail a little in order to insert the tie, and said that the rail rested on the tie after the tie was put in place.

Other bridgemen corroborated the statements that there was no space between the top of the ties and the base of the rail

Section Foreman Dennis stated that he was at bridge 54.92 about five days before the accident occurred; saw the work being done there, and it appeared to him as though the ties fit up under the rails properly He said no slow orders had been put out at this bridge until after the accident

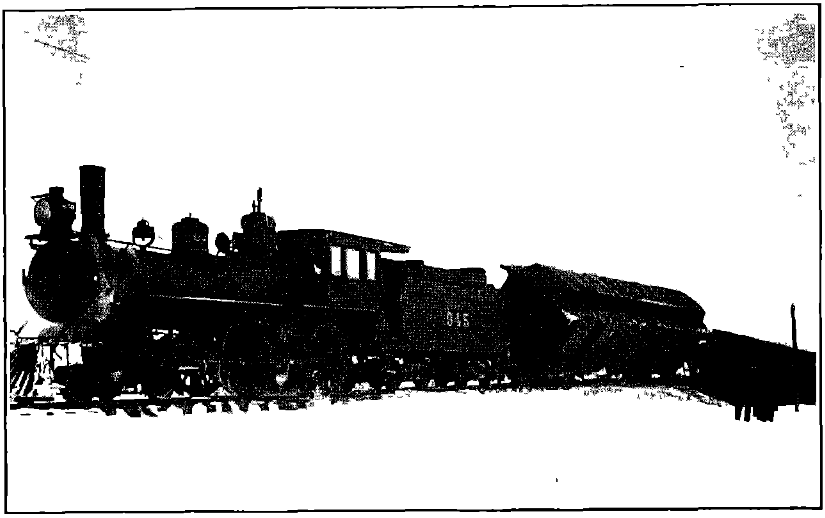

FIG 1 —View of locomotive, engine, and tender on the rails, with derailed mail and baggage cars on east embankment

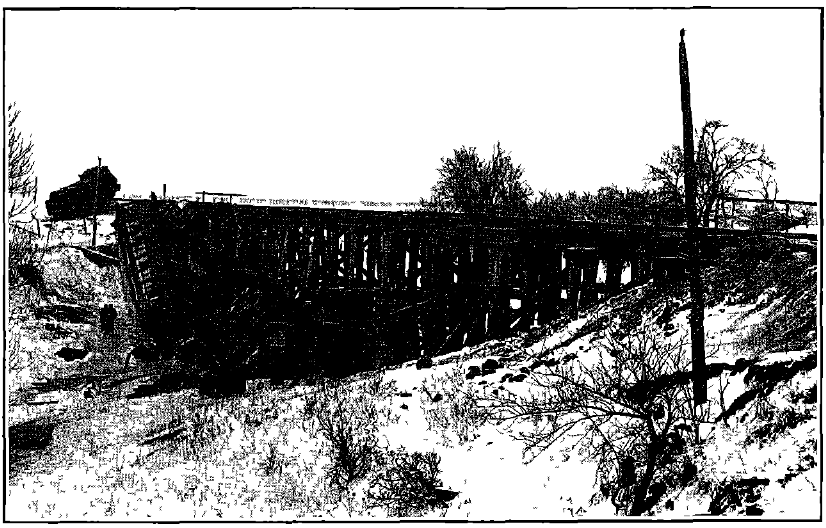

FIG 2 —View of bridge and derailed cars from west embankment

FIG 3 —Demolished coaches in bed of creek

Drawing No. 4522 of the division engineer's office, Kansas City, Mo., purporting to represent the condition at the west end of the bridge prior to the accident, shows a clear space of one-half inch between the rail and the tie under it. The minutes of the investigation conducted by the officials of the road do not substantiate this exhibit. The testimony of the bridgemen was to the contrary. The testimony of Supervisor of Buildings and Bridges Jungling on this feature was incoherent. Supervisor Jungling reached the scene of the accident about eight and one-half hours after it occurred. He testified that, as he figured it out, it looked like there might have been as much as ½-inch space between the rail and the tie. Further on in his testimony he stated that he could not say whether there was any space there or not; and still further on he said that in leveling across the top of the stringers and the pile head it showed to be just about level, his final statement coinciding with the testimony of the bridgemen.

The results of the examination of the rails which failed, conducted by Mr. James E. Howard, engineer-physicist, whose report follows, does not show that the rail failed by lack of vertical support, the origin of the failure of the rail at the west end of the bridge indicating that it was due to horizontal thrust.

REPORT OF THE ENGINEER-PHYSICIST

The derailment of train No. 132 occurred at the westerly end of bridge No. 54.92. The engine and tender passed over the bridge and remained on the rails. The two following cars, a mail and a baggage car, reached the easterly embankment in a derailed condition. The two coaches constituting the remainder of the train were precipitated from the bridge, fell to the banks and bed of the creek below, struck upon their roofs, and were demolished.

The bridge was undergoing repairs, work being in progress at the time of derailment. Figure No. 4 indicates the manner in which the work was being executed at the westerly end. Frozen ground had been excavated and a new bulkhead bent had been placed between the old one and the westerly embankment. Piles 17 inches in diameter were used in the new bulkhead, on which was placed a 12-inch cap, the latter carrying 16-inch pile blocks. A 7½ inch by 8 inch tie was supported by the pile blocks.

The conditions which were present prior to the time of derailment present a number of features of interest in track maintenance. There was a weakened joint at this place. The outer splice bar was partially fractured, old surfaces of rupture existing on each side of the bolt hole next the end of rail marked "B." Part of the flange of the outer splice bar was missing One part of the surface of rupture, separating the flange from the vertical leg of this portion of the

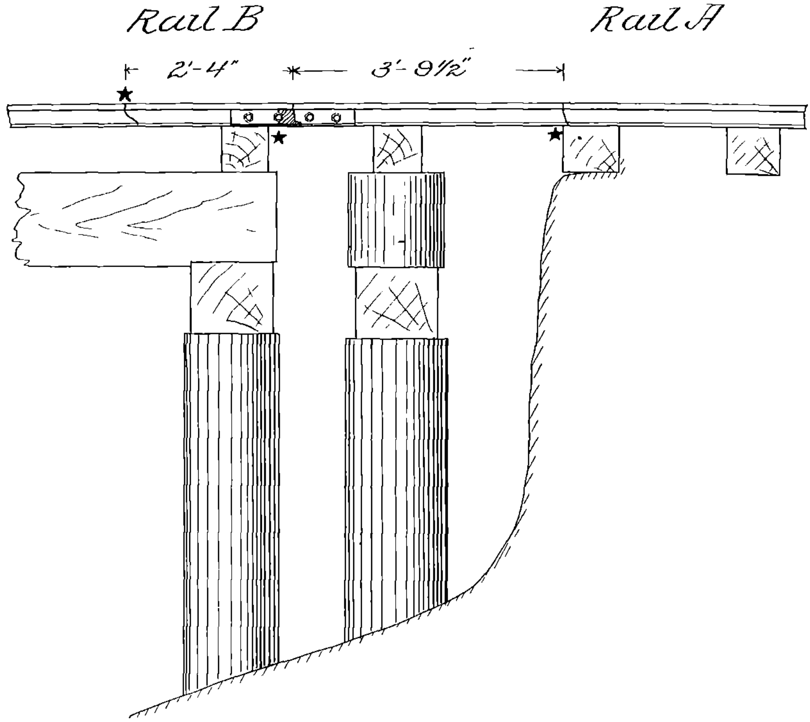

FIG 4—Diagram illustrating manner of inserting new bulkhead bent in bridge Stars on diagram show places of rupture at joint and in the rail

bar, considerably antedated the other part Rails of different shaped heads had been spliced together at this joint, one of which showed decided flange wear on the gauge side of the head, the other rail having experienced little wear on the gauge side of the head The inner flange of rail marked "A" had received injury from spike wear, became brittle at this place and thereby located its point of rupture.

The maintenance of the joint between these rails had, no doubt, been troublesome. New track bolts had been used in the two inner holes Owing to the difference in the shapes of the heads of these rails and the square shoulder presented by the unworn part of rail A, severe thrusts would be received at the joint during the passage of westbound trains until the receiving end of rail A was worn to the shape of the leaving end of rail B The weakened condition of the joint was probably due to the succession of outward blows which it had received.

The shapes of the heads of the two rails are shown by figure No. 5. Section A represents the westerly rail, which was branded

"E T 85 IIIIIIIIII"; section B the easterly rail, the brand mark on which was not ascertained. The outlines of these rails are drawn superimposed on this cut, the shaded portion of which represents the area of metal which had been worn away at the immediate end of rail A by successive blows of wheel flanges. The prism of metal removed was a tapering one, the normal shape of the head being retained up to a distance of about 8 inches from its junction with rail B

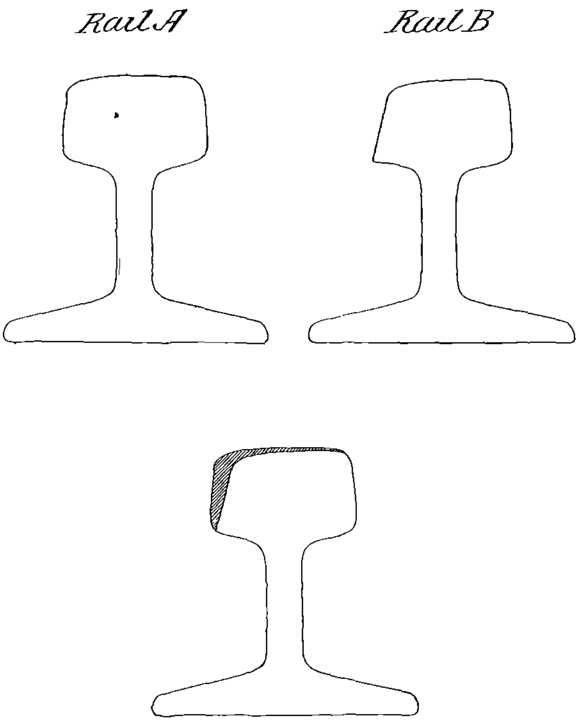

FIG 5 —Diagram showing cross sections of rails A and B, shaded portion of the head, lower figure of the cut, indicating their difference in shape

The several fractures which occurred at the time of the derailment are illustrated by figures Nos. 6, 7, and 8 Figure No. 6 shows the outer splice bar at the joint between rails A and B. Earlier lines of rupture separated the metal on each side of the bolt next the end of rail B, leaving a limited area unbroken next the base of the rail. It is not known at what stage the portion of the flange covering the end of this rail was lost. It exhibited a progressive fracture in part, a longitudinal seam having separated a part of the flange from the vertical leg of the splice bar prior to its complete separation.

Figure No 7 shows the appearance of the leaving end of the longer fragment of rail A. Rupture began at the injured edge of the inner flange, indicated by the star marked on the cut. Hammer action of the rail against the shank of a spike resulted in wearing away the metal by abrasion, and caused such loss in ductility that fracture occurred without display of elongation. The origin of fracture at the inside flange of the base showed that failure at the time of the derailment was caused by an outward thrust against the rail at or in the vicinity of its junction with rail B.

Figure No 8 shows the appearance of the leaving end of the short fragment which was broken from rail B Rupture began at the inside of the head, lower corner, as indicated by the star marked on the cut The metal in the heads of rails becomes embrittled by the cold rolling action of the wheels; the brittleness displayed by this rail is therefore without unusual significance. The incipient point was at the corner of the head, gauge side, extending thence through the head, obliquely through the web, and finally through the base

In their order of sequence the fractures probably occurred—first, at the outer splice bar at the joint, followed by the fractures in rails A and B, which latter two may have occurred practically simultaneously An outward thrust occasioned these several lines of rupture There was no evidence presented in the appearance of the broken rails indicating failure due to lack of vertical support

The chemical analyses of the rails, supplied by Mr. N F Harriman, chemist and engineer of tests, Union Pacific Railroad, is shown on the accompanying table

Chemical analyses of rails A and B

Description	Carbon	Manganese	Phosphorus	Sulphur	Silicon
Rail A	0 467	0 930	0 094	0 069	0 079
Rail B	499	1 014	101	213	085

Examples of rails which have failed by reason of injuries received at the edges of their flanges are met from time to time Figure No 9 illustrates a square break, one of a number which occurred in some 90-pound rails of more recent fabrication than those involved in the present derailment The star marked on the cut indicates the initial point of rupture The bolt holes shown in the web were drilled for attaching splice bars for temporary repairs to the track

SUMMARY.

The results of the examination attaches responsibility for the derailment of train No 132 at bridge No 54 92 to the failure of the

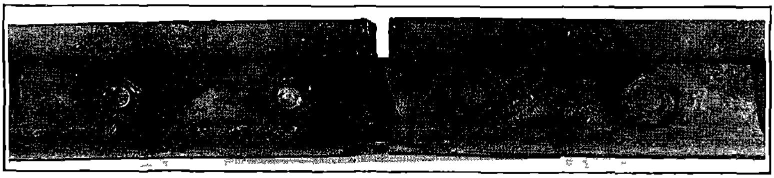

FIG 6 —Appearance of outer splice bar, joining rails A and B

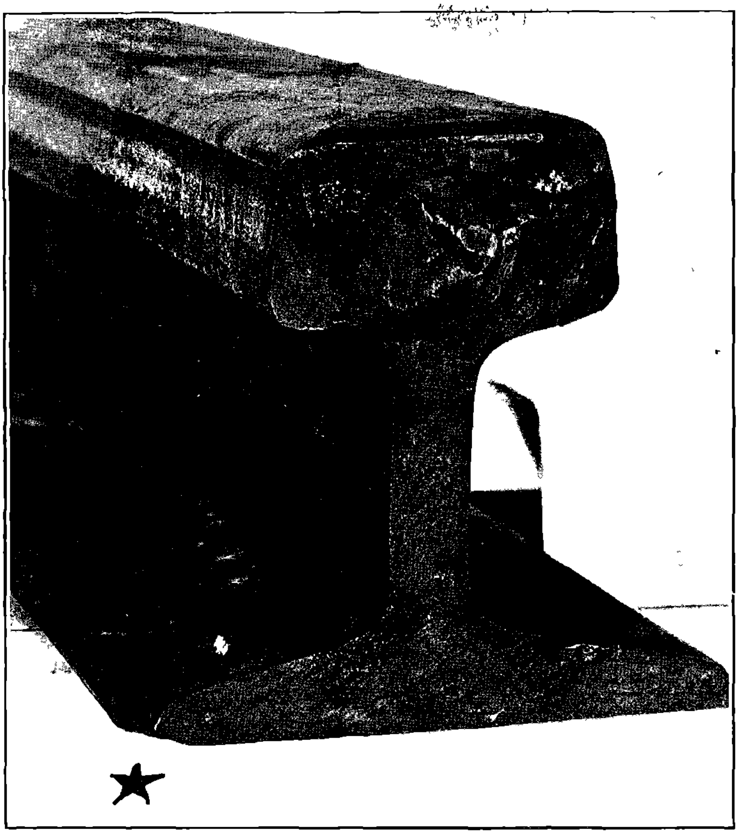

FIG 7 —Leaving end of the longer fragment of rail A Fracture started at edge of flange, gauge side, when injured by spike wedge

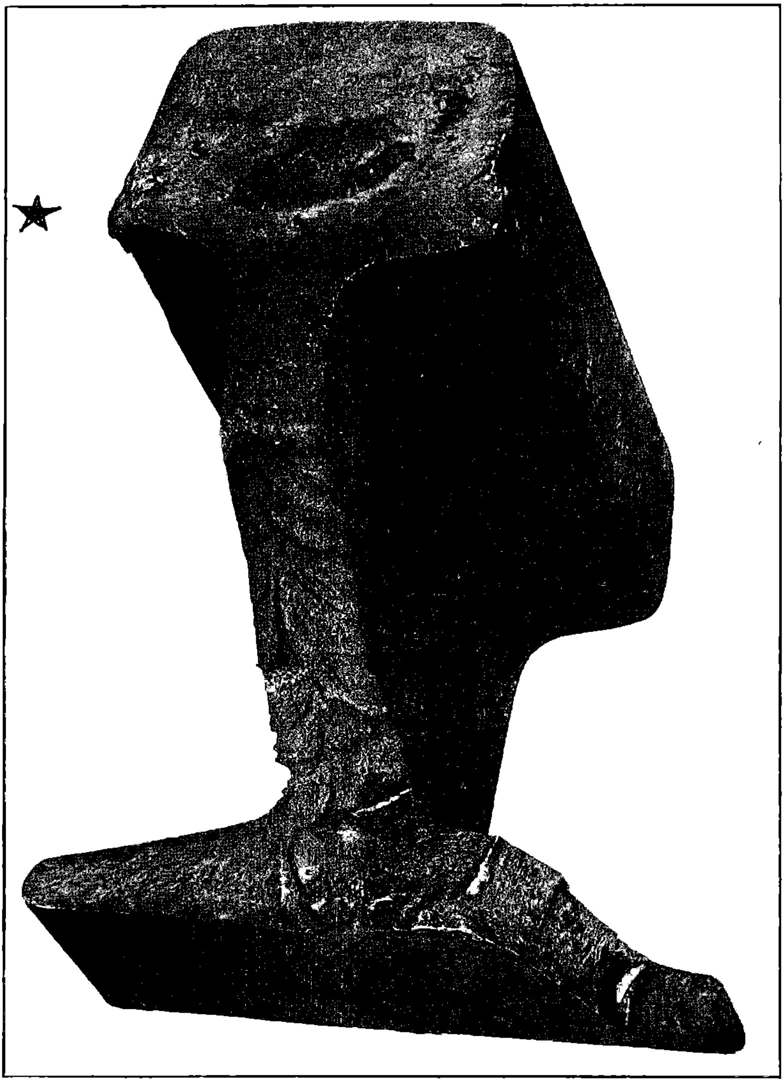

FIG 8—Leaving end of short fragment of rail B Fracture started at lower corner of head, gauge side

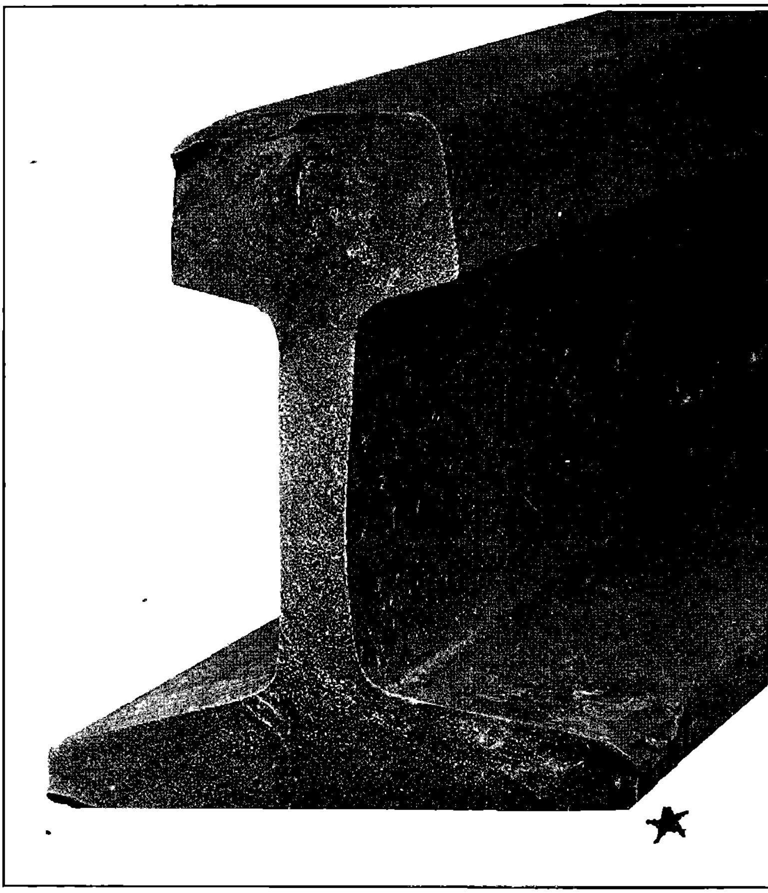

FIG 9 —Fracture of a 90-pound Bessemer rail Illustrating a fracture caused by injured flange track at the joint between rails located near the westerly end of the bridge. Short fragments were detached from the rails adjacent to the joint, secondary lines of rupture it would seem.

The broken rails had different shaped heads. One was considerably worn on the gauge side of the head by flange wear of the wheels; the other showed little wear. They appeared to have been assembled with this difference in shape existing, and worn to a common shape by successive wheel flanges passing over them. The adjustment of shape of the rail with the full head occurred within a distance of about 8 inches of the joint. This abrupt change in section would involve undue strains at the joint, and lead to the fracture of the splice bar as witnessed. This is regarded as one of the earlier circumstances which tended toward ultimate failure.

The injury done the inner flange of rail marked A was also a contributory factor in causing weakness and brittleness of the rail. The brittle fracture displayed by rail marked B is not unusual. The cold rolling of the metal of the head by wheel pressures has such a tendency as this.

The testimony taken upon the circumstances attending this derailment showed that rail A was not spiked to the tie, which was over the new bulkhead bent. A well-spiked track is essential for safety under normal train movements, and it appears that no slow orders were issued restricting normal speeds on this bridge prior to the derailment. Each of the elements of weakness which have been enumerated probably contributed toward and shared in the responsibility for the accident.

The immediate cause of the failure of the track attaches to side thrusts on a weakened joint by a train which was run at customary speed, in the absence of slow orders restricting speeds on the bridge which was undergoing repairs.

Respectfully submitted.

W. P. Borland,
Chief, Bureau of Safety.

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