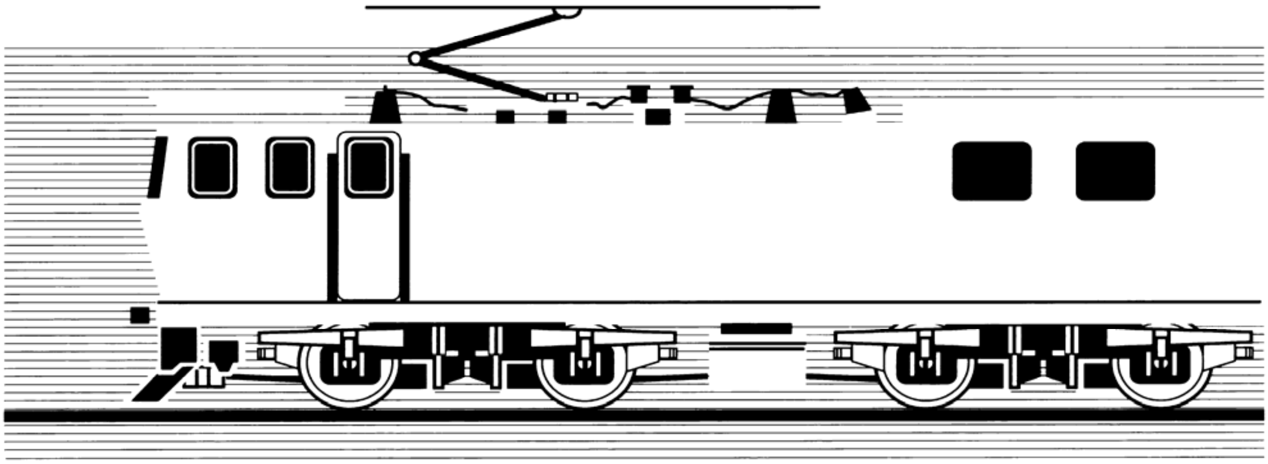
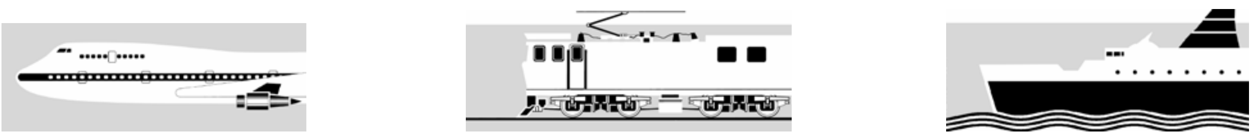


R A I L W A Y O C C U R R E N C E R E P O R T

05-118 **express freight Train 245, derailment, Ohingaiti** **27 July 2005**



TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

Report 05-118

express freight Train 245

derailment

Ohingaiti

27 July 2005

Abstract

On Wednesday 27 July 2005, at about 1428, wagon ZH519 on Train 245, a Karioi to Wellington express freight service, derailed near Ohingaiti, between Mangaweka and Mangaonoho, at 225.127 km on the North Island Main Trunk. The derailed wagon was dragged about one kilometre before the train parted and the brakes were applied automatically. The wood pulp inside the wagon caught fire as a result of the friction heat created by the derailed wheel sets, piercing the wagon deck.

When the wagon was at about 227.872 km, the trailing left-hand bogie side frame fractured through the pedestal roof at the trailing end. The wagon travelled a further 2.75 km in a collapsed state before striking timber panels at a private level crossing, causing it to derail.

There was minor track damage as a result of the derailment, but wagon ZH519 was destroyed.

Safety issues identified included:

- the visual inspection of the bogie side frame for fatigue cracks
- the non-visual inspection of the bogie side frame
- the procedure for welding the wear liner to the pedestal roof
- the location of dragging equipment detector units.

One safety recommendation was made to the Chief Executive of Toll NZ Consolidated Limited to address the safety issues.

Contents

Figures

Abbreviations

AAR	American Association of Railroads
DED	dragging equipment detector
HAZ	heat-affected zone
km	kilometre(s)
km/h	kilometre(s) per hour
m	metre(s)
mm	millimetre(s)
MPa	megapascal(s)
NIMT	North Island Main Trunk
t	tonne(s)
T14	Type 14 bogies
UTC	co-ordinated universal time

Data Summary

Train type and number:	express freight Train 245
Date and time:	27 July 2005 at about 1428[1]
Location:	Ohingaiti
Persons on board:	crew: 1
Injuries:	nil
Damage:	wagon destroyed and minor track damage
Operator:	Toll NZ Consolidated Limited (Toll Rail)
Investigator-in-charge:	P G Miskell

[1] Times are New Zealand Standard Time (UTC + 12 hours) and are expressed in the 24-hour mode.

1 Factual Information

1.1 Narrative

1.1.1 On Wednesday 27 July 2005, Train 245 was a Karioi to Wellington express freight train consisting of 2 DC class locomotives in multiple, hauling 19 ZH wagons loaded with wood pulp for a gross weight of 956 tonnes (t) and a total train length of 310 metres (m). The train departed Karioi at about 1228 and was driven by a locomotive engineer.

1.1.2 At about 1425, as Train 245 passed 227.872 kilometres (km) on the North Island Main Trunk (NIMT), between Mangaweka and Mangaonoho, the trailing end of the trailing bogie left-hand side frame on wagon ZH519 fractured. The wagon continued to run on the track for about 1500 m when the trailing axle of the trailing bogie struck timber panels on a private level crossing, but the wagon did not derail.

1.1.3 The wagon stayed on track for a further 1250 m until the trailing bogie of ZH519 rode up onto the timber panels at the next private level crossing, at 225.127 km. This twisted the bogie to the left, allowing the right-hand trailing wheel to drop in between the running rails. The wagon continued on with both axles of the trailing bogie derailed.

1.1.4 At about 1429, the train lost brake pipe pressure and the brakes applied automatically. The locomotive engineer looked back along the train and saw a cloud of dust. Once the train had stopped, he radioed train control to advise that Train 245 had probably derailed.

1.1.5 The locomotive engineer left the locomotive cab to check his train and to determine the extent of the track damage. He saw that wagon ZH519, the 12th wagon back from the head, had derailed and that the wood pulp inside the wagon was smouldering. An off-duty fire officer who was travelling north on State Highway 1 had seen the smouldering wagon and had already called out Fire Service personnel from both Mangaweka and Taihape before the locomotive engineer reached the derailed wagon.

1.1.6 Train services resumed at about 2000.

1.2 Site information

1.2.1 The track between Mangaweka and Mangaonoho was single line. The signalling and interlocking at these crossing loops were remotely controlled from the national train control centre in Wellington.

1.2.2 The maximum authorised speed between Mangaweka and Mangaonoho for express freight trains was 80 kilometres per hour (km/h). However, there was a 50 km/h permanent speed restriction in force for all trains passing through Tunnel 10.

1.2.3 Intermittent light marks on the running edge of the left-hand rail (in the direction of travel) were visible at about 230 km, inside the 550 m long Tunnel 10. There were no similar marks present on the rail outside the tunnel.

1.2.4 The pedestal leg separated from the left-hand trailing bogie side frame on wagon ZH519 and was found about 3 m to the left of the track at 227.872 km (see Figure 1). When the bogie side frame fractured, the train was travelling on straight track up a 400 m long, 1 in 73 incline. The track consisted of 50 kilograms per metre g/m continuous welded rail, fastened to concrete sleepers with Pandrol fastenings and supported by clean ballast with full cribs and shoulders. The track geometry was within maintenance tolerances.

1.2.5 There were light marks on the left-hand end of the sleepers (in the direction of travel), and some bent rail fastenings between 226.38 km and 225.127 km. The sleeper bruising became more pronounced from 225.127 km to where derailed wagon ZH519 stopped at 224.17 km, some 3.75 km past the point where the side frame fractured (see Figure 2).

1.2.6 The train parted between wagons ZH519 and ZH461 as a result of the derailment but their buffers were touching when the train stopped.

1.2.7 A precautionary 25 km/h temporary speed restriction was imposed over the track affected by the derailment. The speed restriction was removed following a daylight inspection the next morning.

Figure 1
Fractured pedestal leg found trackside

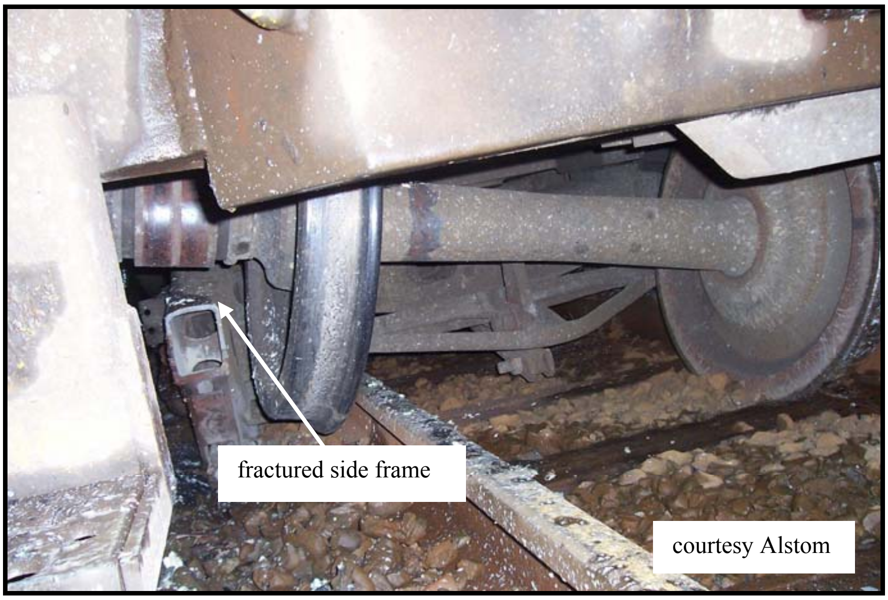


Figure 2
Derailed trailing bogie

1.3 Locomotive event recorder

1.3.1 The locomotive event recorder data was provided for analysis.

1.4 The locomotive engineer

1.4.1 The locomotive engineer had 25 years' driving experience with Toll Rail and its predecessors. His locomotive engineer Grade 1 certification was current. On the day of the derailment, he commenced his shift at Palmerston North depot at 0600 and travelled by road to Karioi to take up the running of Train 245.

1.4.2 As Train 245 was departing Karioi, the locomotive engineer was contacted by the train examiner operations and advised that the brakes had locked on the sixth wagon, ZH1236. After the locomotive engineer stopped the train, the train examiner bled the brakes and carried out a roll-by inspection to confirm that the brakes were not dragging.

1.4.3 The train stalled as it travelled around a 50 km/h curve while climbing the 1 in 60 ruling gradient approaching Waiouru. The locomotive engineer set back the train, before continuing on to Waiouru. At Waiouru, he walked the length of the train and bled the brakes on all wagons. The locomotive engineer had no further braking issues with the train.

1.4.4 The locomotive engineer said that when he walked back to derailed wagon ZH519, he knew that it would be only a matter of time before the smouldering wagon burst into flames (see Figure 3). He asked the train controller to turn the overhead power off then secured the rear portion of the train by applying handbrakes.

1.4.5 He advised train control when Fire Service personnel arrived on site and advised the fire chief that the overhead wires were to be treated as live and that they were to wait until a traction lineman arrived to secure earth straps on the overhead contact wire before fighting the fire.

1.4.6 At about 1520, the locomotive engineer uncoupled the front portion of the train from the derailed wagon and moved it about 30 m clear of the smouldering wagon. Shortly afterwards the product in the derailed wagon burst into flames.

1.4.7 At about 1530, after the traction lineman had secured the earth straps, the locomotive engineer gave permission to the Fire Service personnel to begin fighting the fire.

Figure 3
Wagon ZH519 placed trackside

1.5 Dragging equipment detectors

1.5.1 Many dragging equipment detector (DED) units have been installed on the rail network since 1993. Dragging or derailed equipment was detected by frangible plates mounted in 5 sections, 3 between the running rails and one on either side (see Figure 4). This bar formed part of an electrical circuit which provided an alarm output if any section of the bar no longer provided electrical continuity, for example if it was broken by dragging equipment.

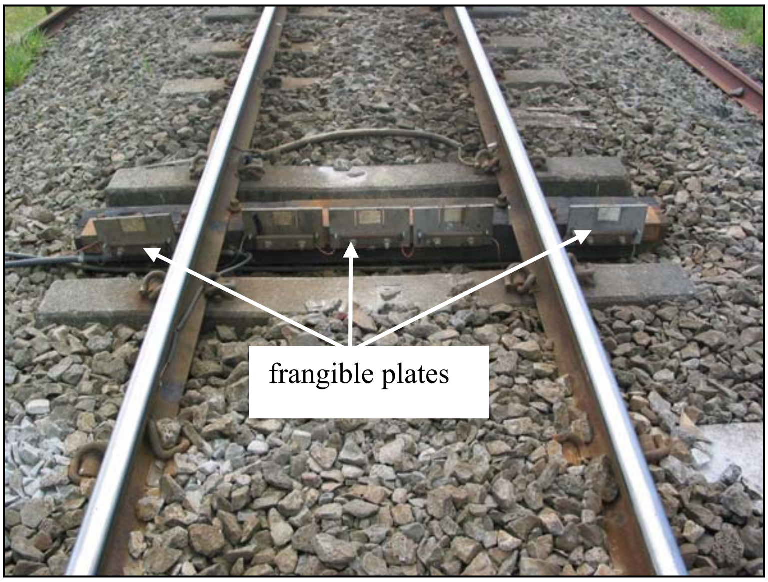


Figure 4
Example of a dragging equipment detector

1.5.2 The dragging equipment alarm was fed into a radio controller that performed the following functions:

- sent an alarm message to train control – this alarm continued at regular intervals until acknowledgement was received from the train control radio computer
- activated a voice message over the local radio channel (channel 1) for immediate advice to any trains in the vicinity. This voice message was heard twice.

1.5.3 The nearest DED was located at 207.71 km, between Mangaonoho and Hunterville, about 17 km south from where the wagon derailed. The nearest unit north of the derailment site was at 309.95 km, a distance of 102.24 km.

1.5.4 By way of comparison, there are at least 16 DED units located between Karioi and Taumarunui, a distance of 90 km.

1.5.5 ONTRACK advised that DEDs were installed to provide network protection by ensuring trains detected as having dragging equipment could be stopped before causing too much damage to the infrastructure. Historically there was no policy for determining the location for installing DEDs. Usually, sites were incorporated with heat detection sites or were installed at locations where additional capacity was available through the centralised traffic control signalling cables for communicating with train control. These latter installations were mostly between Hamilton and Auckland on the NIMT.

1.5.6 Although there was no fixed plan for the ongoing installation of additional DEDs, ONTRACK had identified Kaimai Tunnel as a potentially vulnerable area and was working towards installing the equipment at the approaches to the Tunnel.

1.6 Wagon inspections

1.6.1 Toll Rail's Mechanical Code M2000 required all freight wagons to undergo a pre-departure check, a B-Check and a C-Check. A B-Check covered safety-critical items and was performed when 2 or more brake blocks were changed or after an incident. The more detailed C-Check was performed generally every 24 months, with an upper limit of 27 months. A C-Check could be brought forward if a wagon had been involved in a derailment or collision or had a fault with braking.

1.6.2 Clause 3.4 of the Code stated in part:

> each side frame and bolster must be intact, with no crack of 10 mm or more. All cracks must be reported.

No side frame cracks had been identified on wagon ZH519 before the derailment.

1.6.3 A pre-departure check was a thorough walk-around inspection undertaken by yard operating staff before a train departed from a terminal and included the following below-wagon-deck items:

- observe the condition of the brake blocks
- confirm that the handbrakes are released and the lever is in the crotch
- rectify any leaking brake hoses or replace burst hoses
- check the wheels/tyres
- check bogie springs
- check for loose/hanging brake gear and rigging.

The Code required a Train Inspection Certificate to be signed off by a qualified person confirming that the train had been inspected and was in a proper condition for safe running. The completed Certificate was then attached to other train documentation and retained in the locomotive cab until the train reached its destination. The locomotive engineer confirmed that he was handed a signed Train Inspection Certificate before Train 245 departed Karioi. There were no bad orders loaded against wagon ZH519 at the time of its departure.

1.6.4 The B-Check and C-Check requirements listed in M9202 included the following checks:

B-Check – Bogie/suspension	
Springs:	In place, secure and intact.
Bearing keeps:	Held securely in place.
Liners:	Secure. Not broken.
Wedge heights:	Within limits (use Snubber Gauge if in doubt).
Bearing adapters:	In place. No visual signs of damage.
Dampers:	Secure. No excessive oil leaks.
Horns:	Not bent or loose.
Bearings:	No sign of overheating. Cap bolts in place. Backing rings secure. No excessive grease leakage.
Brake blocks:	Within wear limits.
VTA valve:	Gap setting correct (W.M.T. only). Plunger and stop in line. Air supply hoses in place.

C-Check – Bogie/suspension

Springs:	In place, secure and intact.
Bearing keeps:	Held securely in place.
Liners:	Secure. Not broken. Not worn more than 50% of original thickness.
Wedge heights:	Within gauge limits.
Bearing adapters:	In place. Not damaged or worn.
Side bearer:	Not damaged or worn.
Dampers:	Secure No excessive oil leaks.
Horns:	Not bent.
Bearings:	No sign of overheating. Cap bolts in place. Cap bolts secure. Backing rings secure. No grease leakage.

1.7 Wagon ZH519

1.7.1 Wagon ZH519 had a tare weight of 19.6 t and was designed to carry a payload 36.8 t. The wagon was part of a dedicated fleet of 22 ZH wagons used to convey wood pulp from Karioi to Port of Wellington for export. These high-capacity box wagons were converted from ZA wagons at Hillside from 1995 to create a higher, wider body wagon with a capacity of 95 cubic metres.

1.7.2 Although the wagon had not passed over a weighbridge, either before Train 245 departed Karioi or while in transit, a gross weight of 53 t was declared on the consignment documentation.

1.7.3 ZH519 had standard 3-piece bogies, as used on most freight wagons worldwide. The 3 main "pieces" were one bolster and 2 side frames (see Figure 5). The bolster was supported by 2 sets of coil springs. The larger-diameter coil springs, known as primary suspension, provided vertical support. The smaller-diameter coil springs, known as wedge springs, applied pressure to a friction wedge to provide wagon damping[2].

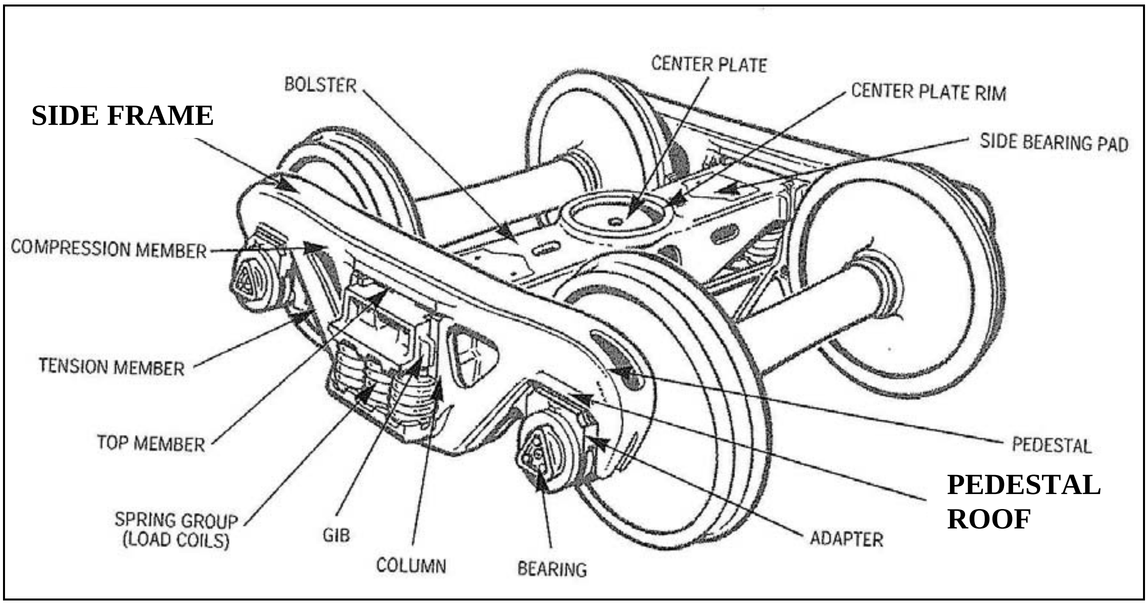


Figure 5
Nomenclature of bogie components

[2] Damping reduced oscillation of a wagon while in motion.

1.7.4 The bogies used on ZH class wagons were known as Type 14 bogies (T14). The T14 bogie design dated back to a 1960s standard, so the current American Association of Railroads (AAR) material standards were not relevant.

1.7.5 The original Australian design/manufacture of the T14 specified that the side frame material was to have a minimum tensile strength of 460 MPa and a maximum carbon content of 0.30%. The original New Zealand specification required nothing more than a "cast steel" 0.2% − 0.22% carbon content. Steel manufactured with this carbon content would have a tensile strength of 450 – 460 MPa.

1.7.6 The bogie side frames were designed to carry a load equal to the rated load of the bearing with which they were fitted. The T14 used the Class C AAR package bearing, rated at 15.2 t per axle. In service in New Zealand, the T14 bogie was rated at 14.3 t per axle, 6% below the bogie side frame nominal rating.

1.7.7 Toll Rail confirmed that AAR standards had not initially applied in New Zealand but were now used for convenience. However, this was not the case in the 1960s and compliance with AAR standards was not relevant.

1.7.8 The manufacturer's marking indicated that the bogie was manufactured in Japan in 1981. From Hillside's reference mark on the bogie, it was established that the failed bogie had its last major overhaul at Hillside on 27 October 2000, when the following components were replaced with either new or refurbished units:

Bolster	friction wedges
Side frames	column liner
	adapter liner
	pocket liner
Brake beam	supplied to specification
Springs	main outer
	main inner
	friction inner
	friction outer

The overhaul work was carried out to Toll Rail's M9200/02 specification.

1.7.9 All wheel sets were replaced on wagon ZH519 on 27 October 2004.

1.7.10 The last four B-Checks and two C-Checks were carried out on wagon ZH519 on:

- 14 June 2005 2-year wagon C-Check
- 3 February 2005 wagon B-Check
- 7 September 2004 wagon B-Check
- 17 June 2004 2-year wagon C-Check
- 25 May 2004 wagon B-Check
- 4 May 2004 wagon B-Check.

1.7.11 In addition to the most recent C-Check, a separate audit of the Karioi wagon fleet was carried out on 18 June 2005. The extensive audit involved examining, measuring and recording the condition of spring packers, wheel tread condition, brake beams, brake rigging, headstocks, bearings, bogie side frames and the wheel profile. No exceptions on wagon ZH519 were identified during the audit.

1.8 Maintenance procedures for attaching pedestal roof wear liner

1.8.1 Toll Rail's drawing 11051499 showed the weld attaching the pedestal roof wear liner as a 6 millimetres (mm) fillet weld applied down both sides of the liner but not across the end of the liner (see Figure 6).

1.8.2 After the derailment, a number of other bogie side frames were inspected and about 20% of them had welds extending around the corner on the end of the pedestal roof liner.

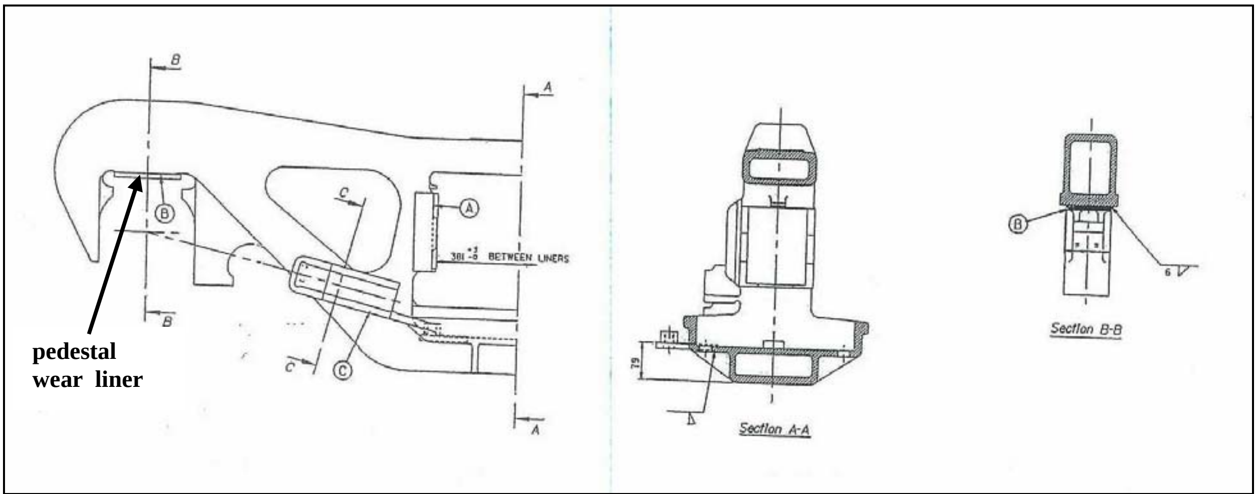


Figure 6
Attaching pedestal roof wear liner

1.9 Examination of the fractured bogie side frame

1.9.1 The separated portion of the side frame was recovered and taken to an independent metallurgy laboratory for examination. The side frame was essentially a box frame onto which a wear liner was welded (see Figure 7).

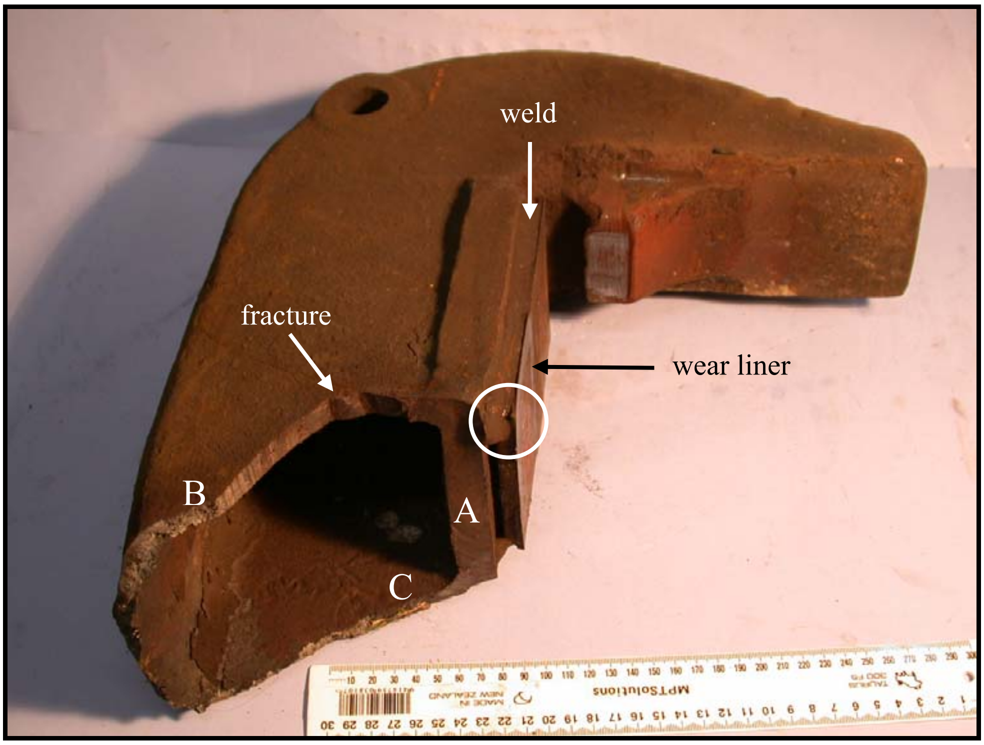


Figure 7
Failed side frame with end of fillet weld (circled)

Visual examination

1.9.2 The side frame had fractured through the box section. The fracture propagated approximately perpendicular to the axis of the box section then changed direction to about 45 degrees to the axis. The fracture was covered in a medium to dark brown corrosion product consistent with iron oxide.

1.9.3 The weld that attached the roof wear liner to the side frame extended about 15 mm around the end of the liner and into an area in the side frame that is highly stressed. The weld at this point was approximately 12 mm.

1.9.4 The fracture exhibited a fatigue crack that originated from the toe at the end of the fillet weld with the side frame (see Figure 8) and propagated through one side of the box section, labelled A in Figure 6, and up the 2 adjacent sides of the box section to positions labelled B and C. The dotted white line in Figure 8 indicates where the weld was sectioned for more detailed examination.

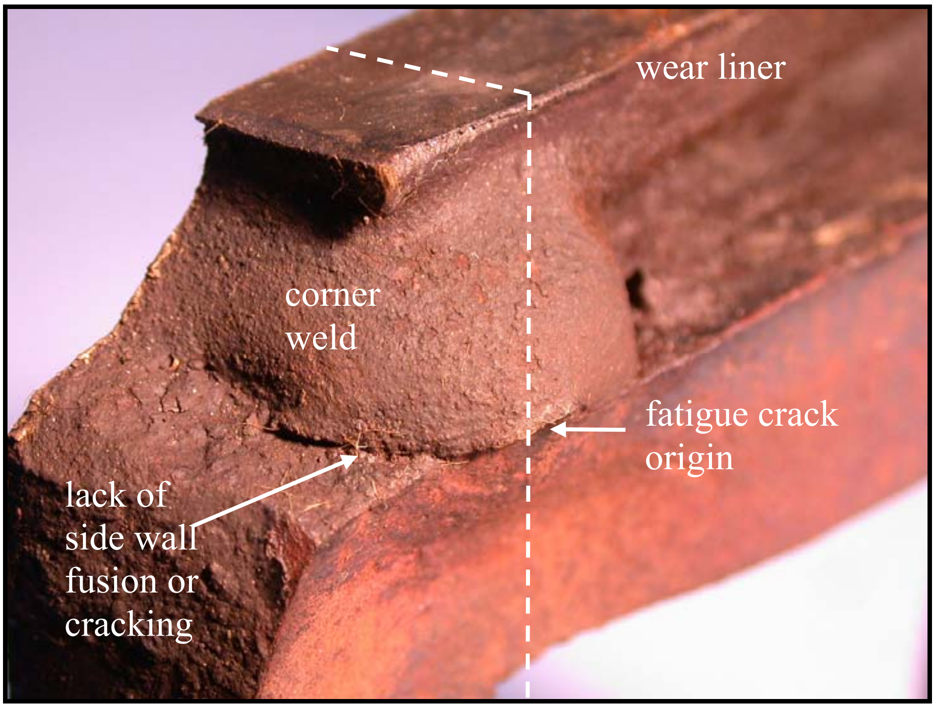


Figure 8
Close up of the corner weld

1.9.5 The fatigue fracture traversed about 50% of the perimeter of the box section. The fatigue crack in region A was very fine, whereas gradually broadening beach marks were present towards regions B and C. Beyond regions A, B and C the fracture exhibited overload.

1.9.6 The fracture was cleaned with an inhibited acid solution and the surface in region A still exhibited a dark brown corrosion product, indicative of old corrosion. The corrosion product on the fracture surface beyond region A was removed and the fracture surface was relatively clean with a metallic look, indicating that the fracture in these regions was more recent than at A.

1.9.7 The end of the fillet weld exhibited, at its toe, a lack of sidewall fusion with the side frame. However, there was no evidence of a defect on the fracture surface from where the fatigue crack originated.

1.9.8 There was no evidence of impact or external damage found on the side frame.

Metallurgical examination

1.9.9 A section was cut through the wear plate, fillet weld and side frame for a more detailed examination (see Figure 9). At the end of the cutting, the box section closed on the hacksaw blade, indicating that there were circumferential compressive stresses in that region of the assembly.

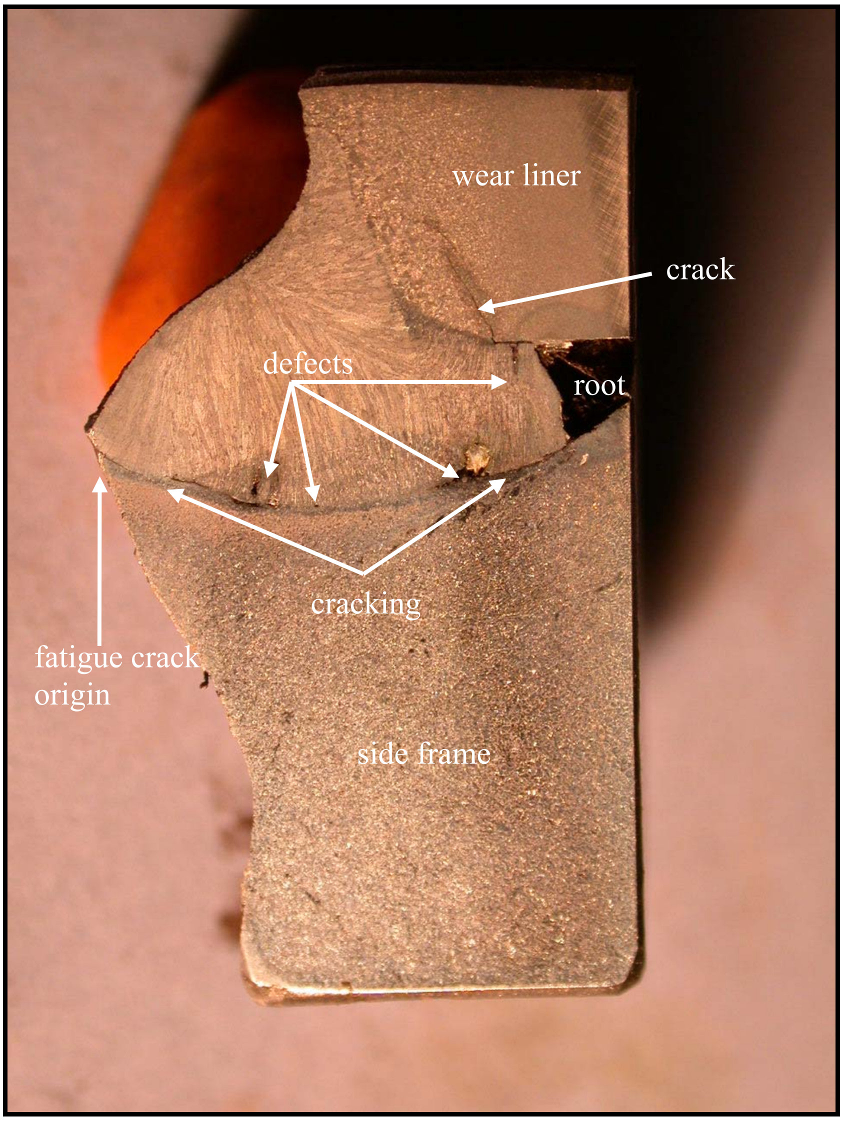


Figure 9
Section showing the weld, defects and cracking

1.9.10 There was considerable cracking present in the following locations, as marked in Figure 9:

- at the toe of the weld in the heat-affected zone (HAZ) in the side frame at the origin of the fatigue crack (see Figure 9)
- in the HAZ between the toe and the root of the weld
- in the HAZ at the root of the weld on the side frame (see Figure 10).

Figure 10
Origin of the fatigue crack in the HAZ

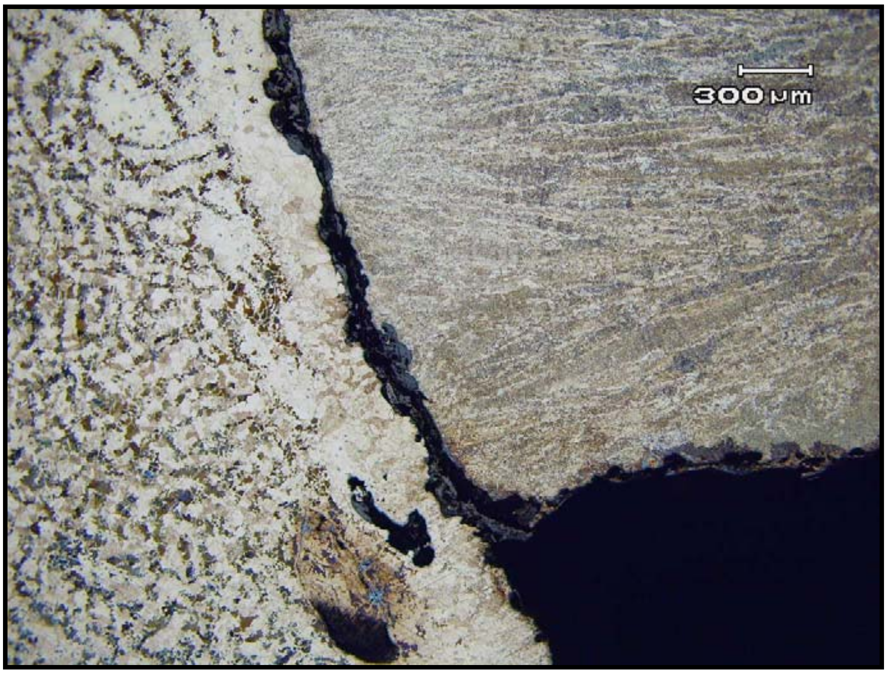


Figure 11
Lack of sidewall fusion at the weld root

1.9.11 Most of the cracks were generally open towards the surface and became narrower further into the material, indicating that the cracks were still propagating.

Hardness testing

1.9.12 Vickers hardness tests were performed on the prepared section using a 10 kilogram load and the results are tabled below:

Location	Side frame parent metal	Wear liner parent metal	Weld filler material	Coarse-grained HAZ
HV10	131, 128, 129	225, 210, 216	218, 210, 216	163, 164

A hardness value (HV 10) of 131 was indicative of steel with a tensile strength of 428 MPa.

1.9.13 From the tests it was established that:

- the hardness of the side frame was consistent with normalised low-carbon steel
- the hardness of the wear liner was consistent with material heat treated by hot rolling or hardening and tempering
- the hardness of the weld material was similar to that of the wear liner
- the hardness of the coarse-grained HAZ was intermediate between that of the side frame parent material and the weld material.

1.10 Previous relevant occurrences investigated by the Commission

Occurrence report 04-107, express freight Train 237 derailment, near Kopaki, 24 March 2004

1.10.1 On Wednesday 24 March 2004 USQ7663, the 27th wagon on southbound express freight Train 237, derailed while negotiating a left-hand curve between Puketutu and Kopaki on the NIMT. The wagon ran derailed for about 750 m until it struck the spreader bar on the north-end facing points at Kopaki, derailing the following 4 wagons and parting the train behind the 29th wagon. The condition of the trailing bogie of USQ7663 was found to be a contributing factor to the derailment.

1.10.2 The report noted that Tranz Rail[3] had no unique identification on the bogie and it had therefore not been possible to track either its operational or maintenance history.

1.10.3 On 9 February 2005, as a result of this incident, the Commission recommended to the Chief Executive of Toll Rail that he:

> introduce a regime to provide unique identification of each bogie to enable the tracking of its operational and maintenance history. (094/04)

1.10.4 On 16 March 2005 the Chief Executive of Toll Rail replied in part:

> for the last few years, both Hillside and Hutt workshops have been marking and recording serial numbers on bogies when they are overhauled. Subsequently we can trace when and where a bogie was last overhauled if it is involved in an incident. However it will be several years before all bogies have gone through a workshop for overhaul, to have a serial number assigned.
>
> We are not recording which wagons these serialised bogies are going into, although bogies are checked at a two-yearly C-check and also whenever a bogie is swapped. At this time bogie wear limits are programmed into Alstom's computer system, which creates alerts for more regular checks as the bogie nears its limit.
>
> As bogies are changed based on condition (rather than kilometres travelled or time in service), we are unsure how the serialisation of bogies would help prevent a similar incident.

[3] Tranz Rail was the predecessor to Toll Rail.

Occurrence report 04-130, covering 4 derailments due to axle bearing failures, various locations, 5 November 2004 – 21 March 2005

1.10.5 Between 5 November 2004 and 21 March 2005 there were 4 express freight train derailments where the cause was attributed to a bearing failure. Because of the similarities of the incidents, investigations into them were combined into one report, although each incident was dealt with separately. The incidents were:

- **Occurrence 04-130:** on Friday 5 November 2004, wagon ZH1812 on express freight Train 237 travelling from Auckland to Wellington derailed between Kakahi and Owhango. The derailed wagon activated a DED unit that sent an alert to train control. The train controller contacted the locomotive engineer and the train was stopped about 4 km past the point of derailment
- **Occurrence 05-106:** on Friday 4 February 2005, wagon UKR137 on express freight Train 221 travelling from Auckland to Wellington derailed at Kaiwharawhara. A shunter saw the derailed wagons as the train was berthing at Wellington freight yard
- **Occurrence 05-110:** on Monday 21 February 2005, wagon UK18837 on express freight Train 247 travelling from Auckland to Wellington derailed about 20 m before the north-end main line points at Te Kauwhata. The derailed wagon caused significant damage to the main line points and associated signalling equipment
- **Occurrence 05-114:** on Monday 21 March 2005, loaded coal wagon CB10558 on unit freight Train 842 travelling from Ngakawau to Lyttelton derailed at Jackson on the Midland Line. Six other loaded coal wagons derailed as a consequence of derailment damage to the track. There was significant damage to both track and rolling stock.

1.10.6 On 7 December 2005, as a result of these incidents, the Commission recommended to the Chief Executive of Toll Rail that he:

> develop a system for recording and tracking both new and reconditioned key components used on bogies. (111/05)

1.10.7 On 19 December 2005 the Chief Executive of Toll Rail replied in part:

> It will take 10 years for the implementation to be complete, as bogies can have up to 10 years' life between overhauls.

1.10.8 While the causes of the derailments in Occurrence reports 04-107 and 04-130 and that in subsequent Occurrence report 05-126 detailed below were different, they were all related to bogie failures or defects. The inability to track bogie maintenance and operational history was considered to be an issue in all the investigations because such a history may have been able to better identify the causes of those failures. Therefore, the safety recommendation is equally applicable to this investigation.

1.11 Subsequent relevant occurrence investigated by the Commission

Occurrence report 05-126, express freight Train 246, derailment, South Junction NIMT, 30 October 2005

1.11.1 On Sunday 30 October 2005, wagon UKR84 on Train 246, a Wellington to Auckland express freight service, derailed as it passed over a set of trailing points at South Junction, between Pukerua Bay and Paekakariki. The left-hand leading bogie side frame had fractured through the top end pedestal and collapsed some 3.35 km before the point of derailment. The derailed wagon was dragged a further 3.3 km before the train stopped, causing considerable damage to the track.

1.11.2 The report noted that Toll Rail had no requirement for non-visual tests of bogie components.

1.11.3 On 13 March 2006, the Commission recommended to the Chief Executive of Toll NZ Consolidated Limited that he:

> include within the existing procedure for overhauling bogies, an inspection other than visual only, to confirm the structural integrity of specified components before a bogie is returned to service. (007/06)

1.11.4 On 2 April 2006, the Chief Executive of Toll NZ Consolidated Limited replied in part:

> Toll Rail intends to formally implement this recommendation.
>
> The "Overhaul Manual for Bogies" will be amended specifying bogie components that will require other than visual inspections. The inspection method will also be specified.
>
> It is expected this change will be formally promulgated, following final Technical Committee approval, by end of April 2006.
>
> However, it should be noted that specific testing is now being applied to side frames, bolsters and specified areas of brake beams in anticipation of this Code change.

1.11.5 Safety recommendation 007/06 is also applicable to this report.

1.11.6 On 13 April 2006, the Commission recommended to the Chief Executive of ONTRACK that he:

> review the network protection at operationally critical locations such as but not limited to North and South Junctions (019/06).

1.11.7 On 20 April 2006 the Chief Executive of ONTRACK responded in part:

> ONTRACK accepts this recommendation, and anticipates commencing this review in 2006.

1.11.8 On 12 May 2006, the Chief Executive of ONTRACK responded in part:

> This review will include the location and the effectiveness of the current DED layout.

1.11.9 Safety recommendation 019/06 is also applicable to this report.

2 Analysis

2.1 The bogie side frame failed due to high cycle fatigue followed by ductile overload. A fatigue crack appeared to have been propagating through one side of the box section for some time, possibly years as indicated by the relative smoothness of the crack surface and the degree of corrosion present. On the other hand, the cracks in other parts of the box section were more recent, as indicated by gradually broadening beach marks that suggested fewer cycles, and a faster crack growth, and a surface not as severely corroded as the initiating crack.

2.2 The fatigue crack initiated from the fillet weld at the end of the pedestal roof wear liner rather than stopping at the side. Therefore the non-compliant weld extended into an area that was highly stressed.

2.3 The presence of defects at the interface between the weld fillet and the side frame indicated that there was a lack of side wall fusion at the toe of the weld, and this was probably the initiator of the fatigue crack. The defects could have been introduced at the time the wear liner was replaced during the last major overhaul of the bogie, nearly 5 years before the derailment.

2.4 The defects compromised the performance of the bogie by inducing stresses that, when combined with service stresses, would have exceeded the fatigue limit. However, the fact that the initial fatigue crack extended about 50% across the box section, and that it exhibited high cycle fatigue, indicated that the stresses in the side frame were probably not greatly above the fatigue limit. Because of the action taken by the rolling stock maintenance provider that on all future overhauls the weld attaching the pedestal roof wear liner to the side frame is not permitted to extend beyond the thickened portion of the pedestal roof, no safety recommendation has been made regarding this issue.

2.5 The main fatigue crack had been propagating for a considerable period of time, and it was possible that similar fatigue cracks may have been developing on other bogie frames operating under comparable service conditions. A safety recommendation was made to the Chief Executive of Toll NZ Consolidated Limited to address this issue.

2.6 The cracks observed elsewhere at the end of the fillet weld, other than the fatigue crack origin, were probably also active fatigue cracks that began developing while the main fatigue crack propagated. These cracks were open at the surface and contained corrosion products. The relative openness of the cracks indicated that tensile stresses were present in the weld at these locations. However, the distribution and magnitude of the applied loads were not known.

2.7 The steel used in the manufacture of the side frame appeared to have been within specification. Furthermore, the relatively small differences in hardness value obtained from the prepared section around the welded region indicated that the magnitude of residual welding stresses was probably not severe.

2.8 When constructed, the bogie side frame was made from steel of slightly less strength than specified in an equivalent AAR standard. However, it was used to carry a load less than that specified in the AAR standard. Therefore, in terms of material strength the side frame was fit for purpose as confirmed by nearly 25 years of satisfactory service life.

2.9 Because ZH wagons in the dedicated Karioi fleet convey near the maximum allowable tonnages and travel nearly twice the annual average distance as other ZH wagons in the general fleet, it was vital that correct welding standards were maintained.

2.10 The inspection of wagon ZH519 before Train 245 departed from Karioi would not have detected the fracture on the bogie side frame. Although the crack had propagated through about half the box section of the frame, it probably would have been hidden with accumulated dust and grime. Although the pre-departure inspection did cover items below the wagon deck, the condition of the side frame was not one of those items. The train was stationary at the time of the inspection but once it started to move, the additional stresses created by the movement would have accelerated the fracture process on ZH519.

2.11 B-Check and C-Check inspections of wagon bogies were visual only and, unless a crack was obvious, there was a possibility that it could be missed and a potentially defective bogie returned to service. Often a B-Check or C-Check did not involve a wheel change so the visual inspection of the bogie side frame would be carried out with the wheels in place, further limiting the opportunity for the inspecting staff to identify a crack.

2.12 A fatigue crack in the pedestal roof area was likely to be identified during a bogie overhaul only, and not during other scheduled inspections. Safety recommendation 007/06 made to, and accepted by, Toll Rail as a result of Occurrence report 05-126 addressed this issue and no new safety recommendation has been made.

2.13 While intermittent marks were observed on the left-hand running rail inside Tunnel 10, it was unlikely that these marks were associated with the failure of the bogie sideframe as there were no similar markings on the head of the rail in the 2 km between Tunnel 10 and where the detached pedestal leg was found.

2.14 The train was travelling at about 75 km/h, 5 km/h less than the maximum authorised speed, at the time of the derailment. The derailed wagon was dragged about one kilometre before the air brake pipe pressure was lost and the locomotive engineer became aware of the train parting. From the time the bogie side frame collapsed until the derailment was discovered, the air brake pipe had remained coupled throughout the train and the locomotive engineer would not have any indication that a wagon had derailed.

2.15 The trailing bogie of wagon ZH519 derailed to the left, and while the locomotive engineer had frequently looked back along his train in transit, the track alignment may have prevented him observing the derailed wagon before the train parted and the brakes were applied automatically.

2.16 Although minimal track damage resulted from this derailment, the derailed wagon could have been dragged a longer distance, resulting in substantial track damage, had either the train not parted or the locomotive engineer not been aware that his train had derailed. Because this derailment happened between 2 DEDs that were more than 100 km apart, the potential for these DEDs to protect the network was minimal. This compares with DEDs spaced on average at intervals of less than 6 km north of Karioi.

2.17 The DED at 309.95 km was north from where daily service Train 245 originated. Therefore, the DED at 207.71 km was the first such unit to detect any potential dragging equipment on the train. While the location at which wagon equipment could start to drag or derailments occur is somewhat random, a more even spacing between DED units on the same line would reduce the potential for track damage arising from these incidents. Had ONTRACK not agreed to include the location and effectiveness of the DED layout, as part of the review of the network protection at operationally critical locations, a safety recommendation to address this issue would have been made.

3 Findings

3.1 Wagon ZH519 derailed after the left-hand trailing bogie side frame fractured and collapsed.

3.2 The bogie side frame failed due to high cycle fatigue followed by ductile overload.

3.3 The origin of the fatigue crack was associated with a non-compliant weld that extended into a relatively highly stressed area of the side frame.

3.4 The steel used for the manufacture of the bogie side frame met New Zealand specifications.

3.5 Hardness testing did not indicate a significant reduction in strength that could have contributed to the initiation of the fatigue crack.

3.6 B-Check and C-Check procedures required only visual inspections of bogie side frames.

3.7 No track geometry issues were identified that could have contributed to the derailment.

3.8 The actions of the locomotive engineer did not contribute to the derailment.

3.9 There was a distance of about 90 km before southbound Train 245 passed over the first DED unit, whereas trains travelling between Karioi and Taumarunui would pass over DED units that were spaced on average at intervals of less than 6 km.

4 Safety Actions

4.1 A survey of bogie side frames undertaken by the rolling stock maintenance provider indicated that the weld extending around the corner of the pedestal roof liner may occur on up to 20% of the bogies in service, although in general the weld size was within specification. The rolling stock maintenance provider has stated that on all future overhauls, the weld attaching the pedestal roof wear liner to the side frame is not permitted to extend beyond the thickened portion of the pedestal roof.

5 Safety Recommendation

5.1 On 9 June 2006, the Commission recommended to the Chief Executive of Toll NZ Consolidated Limited that he:

> include within existing inspection procedures for bogie side frames a requirement that staff, as far as each level of inspection allows, check for cracks with particular emphasis on the pedestal roof/tension member area.. (032/06)

5.2 On 15 June 2006, the Chief Executive of Toll NZ Consolidated Limited stated in part:

> Toll NZ intends to have this safety recommendation implemented by 31 July 2006.

Approved on 15 June 2006 for publication

Hon W P Jeffries
Chief Commissioner

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