Report 99-101

Express freight Train 230

derailment

McKays Crossing, between Paekakariki and Paraparaumu

25 February 1999

Abstract

At approximately 2240 hours on Thursday, 25 February 1999, Train 230, a northbound express freight, was travelling on the up main just south of McKays Crossing when dragging brake gear on a wagon near the centre of the train hit the spreader bar of the safety turnout where the line converged to single track. The impact caused the facing points to open and derail 19 of the following wagons. The derailment brought down part of the 1500V overhead traction line and blocked State Highway 1. Fatigue breaks in a brake beam assembly caused it to fail allowing the brake gear to drop. Safety issues identified included quality control of the brake beams to withstand likely cyclic loading. Three safety recommendations were made to the operator.

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The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

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List of Abbreviations

DED	dragging equipment detector
Hz	hertz
km	kilometre
km/h	kilometres per hour
LE	locomotive engineer
m	metre
mm	millimetre
NIMT	North Island Main Trunk
POD	point of derailment
t	tonne
TAMS	total asset management system
V	volt

Rail Incident Report 99-101

Data Summary

Train type and number:	express freight 230
Date and time:	25 February 1999, 2240 hours
Location:	McKays Crossing, between Paekakariki and Paraparaumu, at 41.63 km North Island Main Trunk (NIMT)
Type of occurrence:	derailment
Persons on board:	crew: 1
Injuries:	nil
Damage:	major damage to ten bogie wagons major track damage minor damage to overhead traction gear
Operator:	Tranz Rail Limited (Tranz Rail)
Investigator-in-Charge:	R E Howe

1. Factual Information

1.1 Narrative

1.1.1 On Thursday, 25 February 1999, express freight Train 230 was travelling between Wellington and Auckland. The train consist was locomotives DFT7335 and DC4749, one dead locomotive (DC4231) and 44 bogie wagons. The total train weight was 1480 t with a length of 710 m, and it was crewed by a locomotive engineer (LE).

1.1.2 At about 2240 hours, as the train was entering the single track just south of McKays Crossing, dragging brake gear on wagon ZH1213 (the 21st wagon in the train) impacted on the spreader bar of the facing safety turnout 7A[1] just south of the road crossing, causing the left-hand switch rail to be pulled away from the stock rail.

1.1.3 The gap between the stock rail and the dislodged switch blade allowed the wheels of the following wagons to take 2 roads simultaneously, resulting in 19 wagons becoming derailed. Some of the derailed wagons sideswiped overhead traction support poles, which brought down the 1500V lines. Derailed wagons were strewn over the McKays level crossing, blocking State Highway 1 for approximately 2 to 3 hours before a lane for one way traffic was cleared. Figure 1 shows a general view of the site following the derailment and road clearance.

Figure 1
General view of the site

[1] A safety turnout was provided to ensure that should a northbound train overrun a stop signal it would be diverted away from the main line so as to avoid any conflict with south-bound traffic. The spreader bar connected the 2 switch rails and held them at the correct distance apart.

1.1.4 The LE stated that his first indication that something was wrong was when he experienced a violent stretching of his train and loss of brake pipe air which brought the train to a halt. The LE estimated that the speed of the train prior to the derailment was 65 km/h. The maximum speed was 70 km/h as dictated by the permissible speed through the turnout. After a 3-hour delay at the site while Tranz Rail staff assessed the damage, the LE carried on to Palmerston North with the front portion of the train, which was unaffected by the derailment.

1.1.5 The train examiner operations reported that when marshalling the train in Wellington before departure nothing out of the ordinary was observed, and in particular no dragging brake gear was noticed.

1.2 Track damage

1.2.1 Inspection of the track preceding the point of derailment (POD) revealed the following evidence of dragging equipment:

approximate kilometrage	**description of damage**
22.5 km	first indication of scrape marks on sleepers near Mana
22.8km	brake block piece and spear found in centre of track
23.4 km	intermittent score marks
24.9 km	score marks in Plimmerton Road level crossing
32.0 km	signal cables torn out mid track from 8R signal location
32.1 km	spreader bar to south junction turnout 7B hit and bent 25 mm
35.3 km	left hand side switchblade horn scraped on turnout B9
38.5 km	left hand side switchblade horn scraped on turnout 3A
38.9 km	spreader bar at Paekakariki crossing turnout 5A bent 25 mm
41.63 (POD)	spreader bar at McKays Crossing turnout 7A hit and bent back 140 mm. Figure 2 below shows the extent of damage.

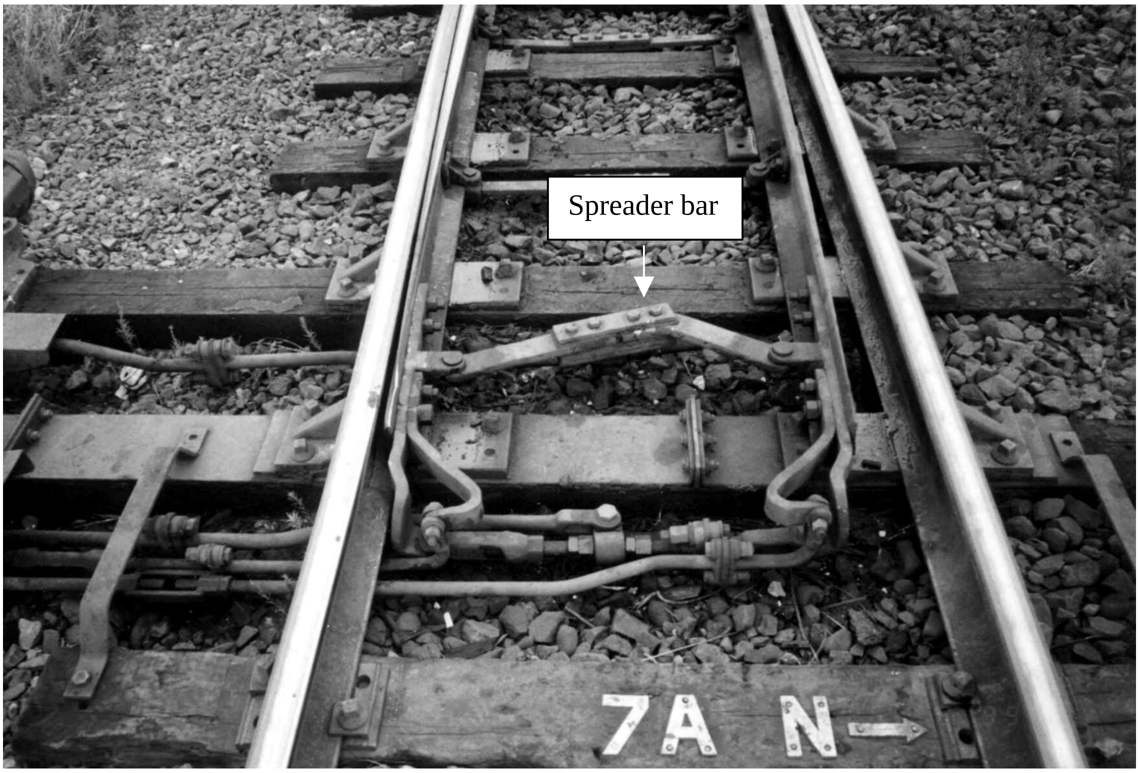

Figure 2
Damage to turnout spreader bar caused by dragging brake gear

1.2.2 As a result of the derailment major track repairs were required over a distance of several hundred metres.

1.3 Wagon ZH1213 bogie details

1.3.1 The bogies on wagon ZH1213 were a standard 3-piece bogie (termed Type 14 by Tranz Rail). The main castings were imported from overseas and the brake beams fabricated in New Zealand. The original design is over 30 years old.

1.3.2 The general braking configuration for the Type 14 bogie is shown in Figure 3. The brakes were applied through the action of the brake pull rod linked to the top of a lever arm which pivoted about a brake push rod at the bottom and carried the centrally pivoted brake beam. With the application of the brakes the action and reaction of the forces on these 2 pivots caused the brake beams to be forced apart and apply the brakes to each set of wheels in the bogie .

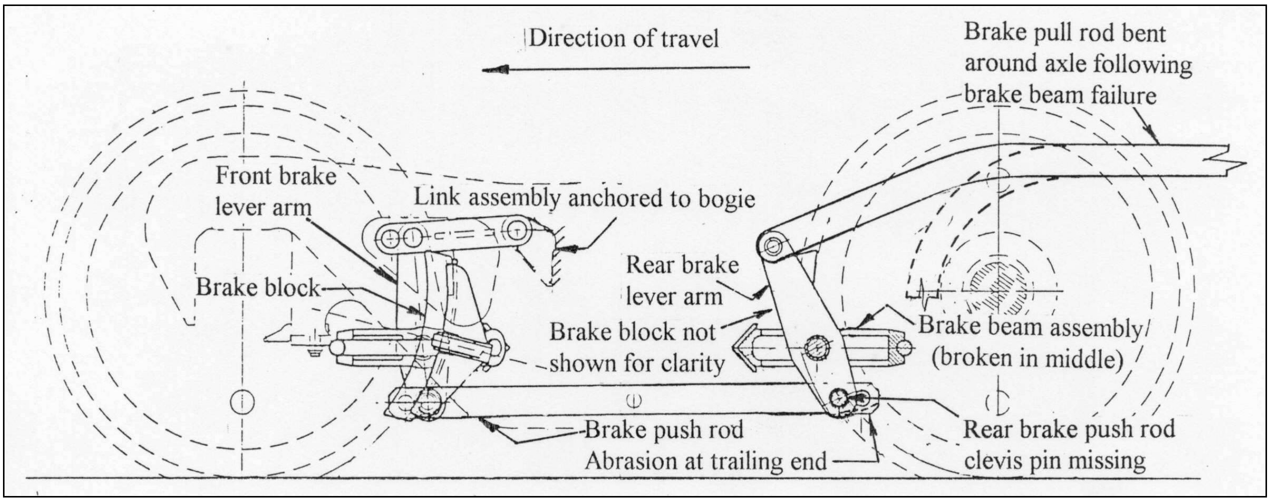

Figure 3
Diagrammatic section of the leading bogie showing the position of the brake components

1.3.3 The main components of each brake beam were fabricated from 3 steel castings (the right and left brake beam heads and the brake beam strut) and 2 rolled steel sections (a 32 mm diameter tension member and an 80 by 80 by 11 mm thick angle iron compression member). The components were welded together to Tranz Rail plan 11051474A dated 7 July 1993 (see Figure 4).

1.3.4 Liners at each end of the brake beams were set into guides in the main bogie sideframes and provided for both the dead load support of the beam and guidance for its movements.

1.3.5 Tranz Rail advised that following the derailment a strength analysis of the brake beam had been carried out which showed that under normal braking loads, the fatigue life would exceed the life of the wagon. They conceded, however, that the fatigue life could be reduced by the effect of vertical dynamic loads such as those induced by track joints or wheel flats. Tranz Rail advised that lack of real loading data in this regard meant that gross assumptions had been made but that even at quite low levels of vertical acceleration fatigue failure of the round bar at the end of a weld in a short period of time was predicted.

1.3.6 A random inspection of brake beams at the Hutt workshop revealed 2 with broken tension rods at the weld adjacent to the head casting. One had been removed for replacement and the other was still in a wagon and ready for replacement. The latter brake beam had a slightly bent compression member resulting from brake application after the failure of the tension member. Tranz Rail advised that approximately 80 Type 14 brake beams were replaced annually throughout the system, and of this number they estimated that approximately 15 were required due to cracks at welds.

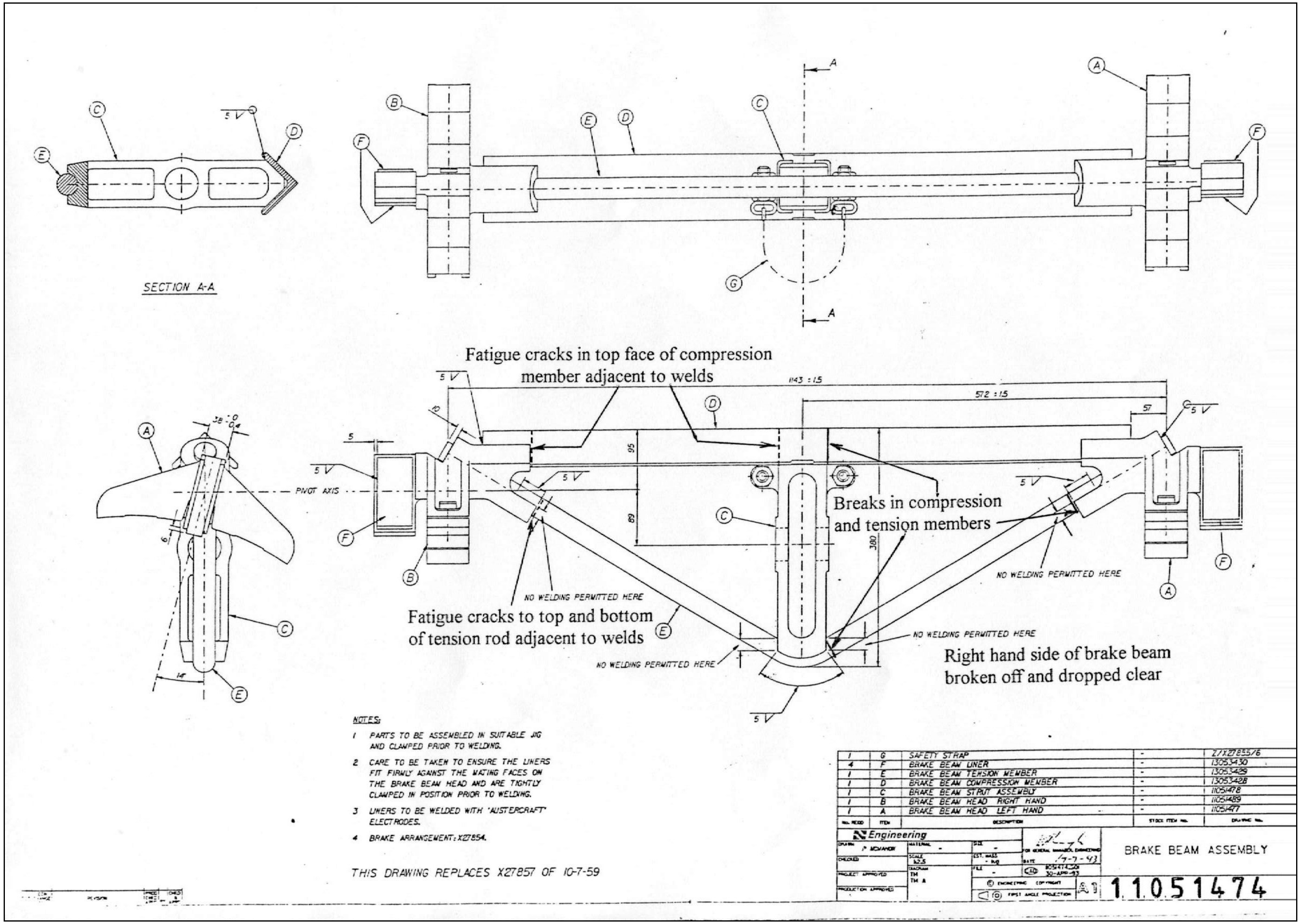

Figure 4
Tranz Rail plan 11051474A
Brake beam assembly

1.4 Damage to wagon ZH1213 brake gear

1.4.1 Prior to clearing the front portion of the train, an examination of wagon ZH1213 revealed that the leading bogie rear brake push rod clevis[2] pin was missing. This had allowed the push rod to trail from the front fixing. The missing pin was not found. The trailing end was abraded on the underside where it had been in contact with the track ballast.

1.4.2 The examination also revealed that the rear brake beam assembly on the leading bogie had broken in the centre and the right-hand section was missing. Breaks had occurred to the 32 mm diameter steel brake beam tension member, and to the 80 by 80 by 11 mm thick angle iron brake beam compression member, both adjacent to the right side of the central strut (see Figure 5). An immediate search for the missing portion was unsuccessful, but it was eventually found by Tranz Rail staff some 8 months after the incident.

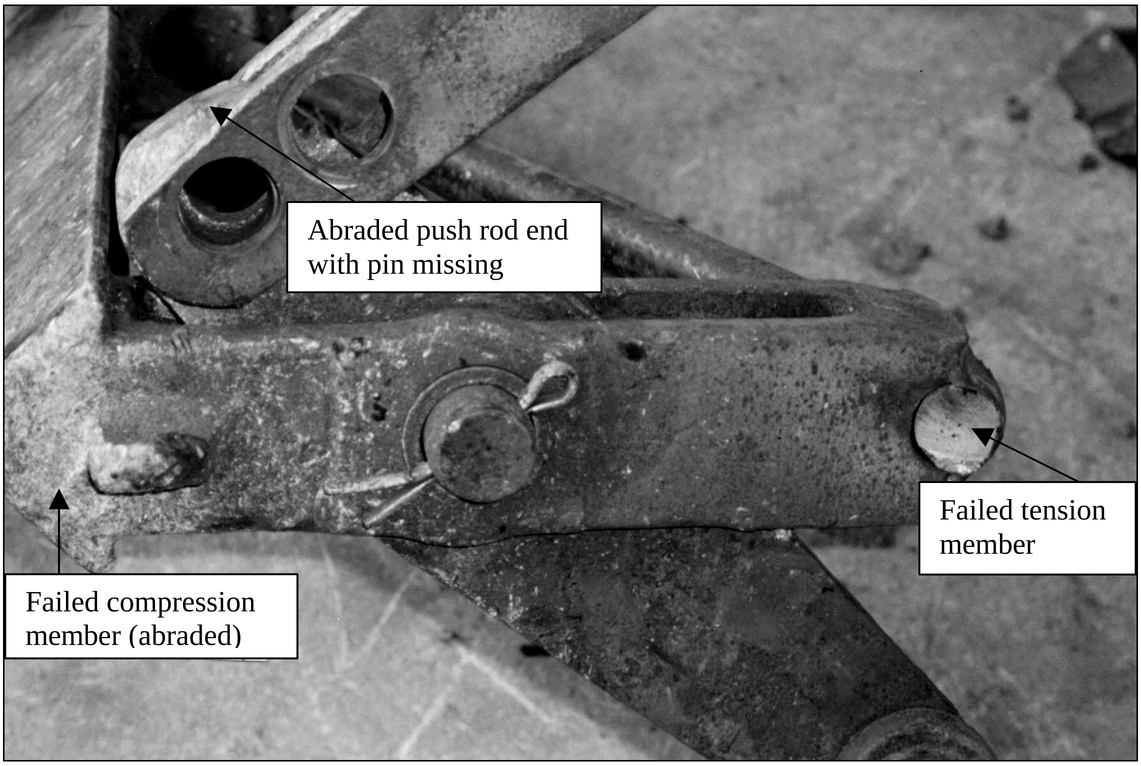

Figure 5
Broken angle compression member (abraded) and tension member on brake beam

1.4.3 The remaining left brake block was broken and unevenly worn on the inner portion of the block, and there were wear marks on the brake beam liner indicating that it had been twisted in the sideframe guide.

1.4.4 The remaining left-hand section of the brake beam had come free from its guide and was attached only by the brake pull rod (through the brake lever arm), which had become wrapped around the trailing axle of the bogie. In this position the broken part of the brake beam had been dragging in contact with the track bed. Figure 6 shows the condition of the pull rod after removal from the wagon.

[2] A clevis is a connection in which a bolt joins 2 parts together, one of which fits between the forked end of the other

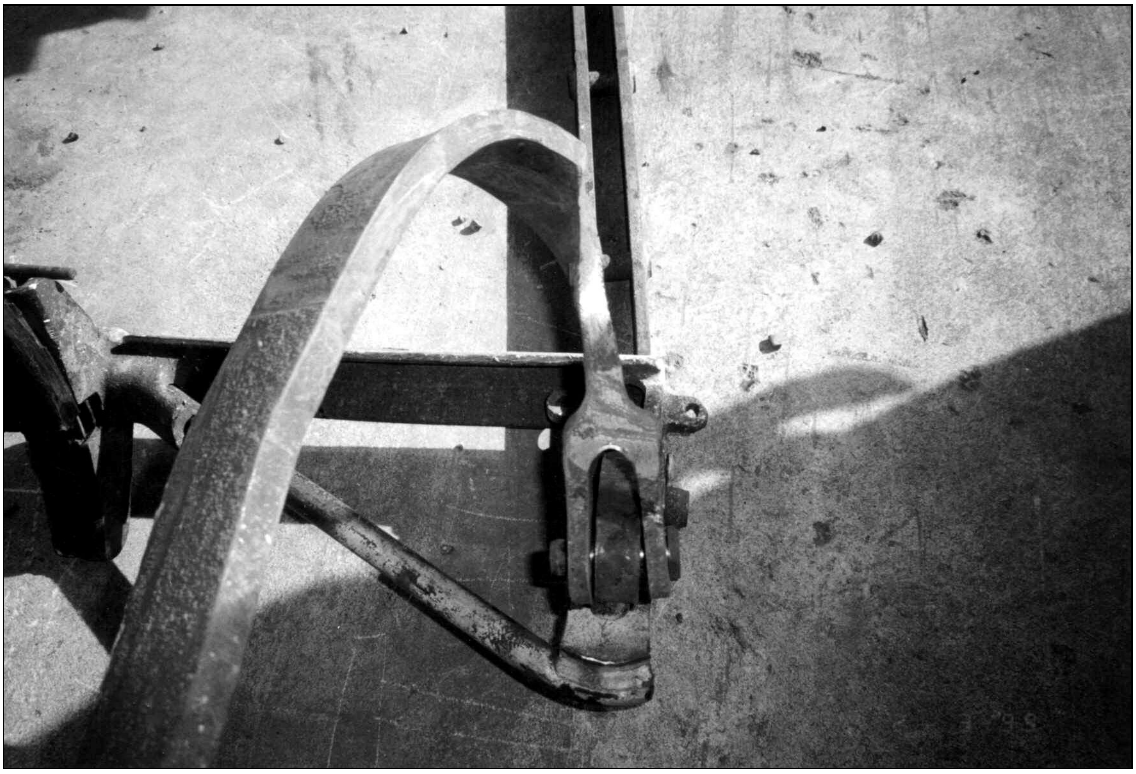

Figure 6
Showing bent brake pull rod

1.4.5 The portion of the brake beam that was recovered 8 months later had the 32 mm diameter tension member missing where it had broken off adjacent to the right hand head casting. The broken end of the angle iron compression member was slightly curved in alignment immediately adjacent to the break.

1.5 Brake beam fabrication

1.5.1 The fabrication of the brake beams had been carried out with the use of purpose-made jigs. Tranz Rail advised that the assembly and welding steps involved in fabricating the brake beam components were subject to specific instructions similar to the draft Job Breakdown Sheet dated 9 March 1999, a copy of which is shown in Appendix 1. Although dated subsequent to the incident under investigation, Tranz Rail advised it was a copy of the old manufacturing procedures which were in effect prior to March 1999.

1.5.2 A Tranz Rail post-incident review of this document found that it was incomplete, and the draft was revised and reissued as task breakdown SDT-JB-0093 dated 29 April 1999. Tranz Rail advised that no copy of the original procedure was retained after its reissue as a draft in March 1999.

1.5.3 Tranz Rail advised that they could not identify whether the beam had been manufactured at Hillside or Hutt workshop. The brake beam was not numbered or dated.

1.6 Testing of the broken brake beam

1.6.1 The broken portion of the brake beam was subjected to laboratory testing to determine the details of the failure.

1.6.2 The break in the angle iron was extensively worn as a result of having been dragged through the track ballast and no analysis of the failure mode was possible. The failure was located next to the weld adjacent to the central strut assembly.

1.6.3 In addition to the break in the angle iron there were 2 cracks. One was at the brake shoe end on the top side adjacent to a weld. This crack was forced open to reveal that it had propagated 36 mm into the angle from the edge. The fracture surface was a red/black rust colour and had been polished due to fretting. The other crack was on the top, adjacent to the central strut, and on the opposite side of the failure. This crack was about 10 mm long and there was also evidence of a possible crack on the bottom side of the angle adjacent to the weld. The position of these cracks are shown on Figure 4.

1.6.4 The tension member that was broken was covered in black scale, typical of a high temperature oxide that is normally present on new "black" bar. Some areas of rust were present. The presence of the black oxide and the small amount of rust indicated that the bar was not very old and likely to have been in service for only a short time. An examination of the other 3 brake beams on wagon ZH1213 showed that none displayed the obvious short service indications of the failed beam. Examination of the fractured surface revealed that it had occurred as a result of 2 fatigue cracks initiated at the edges of the weld (to the central strut) and propagated across the section. The crack on the top side of the bar was a red/black rust colour and about 3 mm deep. The crack on the bottom was free of rust and had propagated about 30 mm across the bar, indicating that it had occurred more recently and grown more rapidly than the top crack.

1.6.5 The tension member also had cracks adjacent to both top and bottom welds at the brake shoe end which were open, indicating that the base material had yielded. Both cracks were red/brown in colour and had initiated at the edge of the weld. One had grown to 4 mm and the other to 9 mm in length. Both had propagated an additional 2 to 3 mm, probably as a result of the initial failure.

1.6.6 The electron microscopic examination revealed that the fatigue cracks had occurred over a relatively large number (thousands) of cycles and were not typical of having occurred over tens of cycles. Fatigue striations (ridges) were about 2000 to the millimetre. For the 9 mm crack this indicated a minimum of 18 000 cycles assuming a constant rate of growth. However, the laboratory report considered it likely that a figure of 50 000 cycles could apply if growth had not been at a constant rate.

1.6.7 The brake lever showed evidence of fretting on both sides where it had been in heavy contact with the slot in the central strut. The middle bush in the lever was loose and the inside of the hole was fretted. The pin was worn 0.2 mm in the bush area but was not bent or obviously deformed.

1.6.8 Damage had occurred to the top face of the brake beam liner and a significant amount of polishing had occurred on the bottom face due to fretting. The corresponding side frame bottom face had been worn away 2.5 mm and had a 150 mm crack.

1.6.9 Chemical analysis of both the angle iron and the tension member showed they conformed to a typical weldable grade of steel to British Standard BS 4360 GR43A.

1.6.10 Vickers hardness tests were carried out on the various components of the brake beam and gave hardness values as shown below:

area	**average reading**	**max heat affected zone**
tension member	147	247
angle iron	177	253
casting	137	442

A maximum hardness of less than 300 is considered to be reasonable.

1.6.11 The welds to the tension member had relatively small weld beads, on one section only 3.5 mm thick compared to the 5 mm specified. The single pass welds present with a narrow throat running parallel to the applied stress had significant stress concentrators at the edge of the weld. Tranz Rail advised that the presence of any weld in this area was a less than ideal compromise necessary for production assembly.

1.7 Wagon history

1.7.1 Wagon ZH 1213 was one of a fleet of captive wagons that had been developed for the Karioi pulp traffic and had been originally certified to run at 90 km/h, but subsequently reduced to 80 km/h for reasons other than running gear limitations. Records showed it was travelling about 6000 km per month before the incident.

1.7.2 Tranz Rail historically had used a TAMS (total asset management system) database to record the maintenance history of wagons. In October 1998 this system was replaced with a German-based computer system (SAP) which incorporated individual wagon history with other functions such as workshop production, inventory and programming. The new system did not allow for the direct transfer of all information from TAMS to SAP and as the latter system was not fully developed at the time of the incident a lot of the historical data was still in the old system or waiting to be entered into the new system.

1.7.3 Repair records for wagon ZH1213 shown below were extracted from the 2 sets of Tranz Rail data for all work associated with code 39 (brake rigging and equipment repairs/adjust) and code 30 (brake blocks/pads) and covered the period up to 6 months prior to the derailment. Tranz Rail advised that the dates quoted are the entry dates into the records and not the repair dates.

TAMS records:

date	**depot area**	**work carried out (by repair code)**
16 June 1998	Wellington	30, 39
17 August 1998	Wellington	30, 39

SAP records:

date	**depot area**	**work carried out (by repair code)**
6 November 1998	Wellington	30
1 February 1999	Wellington	30, 39

In addition to the above specific brake repair work, the wagon was called into both Wellington and Palmerston North to have a variety of other repairs and tests carried out.

1.7.4 Repair records also included 2 Work Report/Request sheets dated 20 October 1998 and 5 November 1998 which gave repair details for wagon ZH1213 carried out at Wellington. The former sheet indicated a broken brake block and a damaged brake beam and recorded 45 minutes for work on the brake block but had not been recorded in either the TAMS or SAP system. There was no indication which of the 4 brake beams on the wagon was damaged and no repair time was recorded against it. The latter sheet, which had been recorded in the SAP system indicated that 2 hours 30 minutes had been spent on the replacement of a spreader bar (an alternative name for a brake beam) and 30 minutes spent on 4 brake blocks. Again there was no indication which of the brake beams on the wagon had been worked on.

1.7.5 In subsequent discussion with the Wellington wagon repair staff they were of the opinion that a brake beam was renewed on each occasion. The method of recording work carried out on wagons was for the repair staff to note in a personal note book work carried out on the floor and for this to be transferred to the Work Report/Request sheets at regular intervals.

1.8 Locomotive event recorder

1.8.1 Tranz Rail advised that the extraction of the locomotive event recorder was not actioned as a result of an internal staff communication problem.

1.9 Dragging equipment detection

1.9.1 Since 1993 Tranz Rail have been progressively installing a number of dragging equipment detectors (DEDs) on key lines. The DEDs are either installed stand-alone, or in conjunction with rail temperature sensors. They comprise of a set of frangible arms approximately 25 mm below rail level and extending between the rails and approximately 1 m outside each rail. When an obstruction such as dragging brake gear (between rails) or dragging bond chains (outside rails) hits the frangible arms it breaks a circuit and alerts Train Control. As of January 1999 there were 29 such installations on Tranz Rail track and a further 34 were proposed.

1.9.2 There were no DEDs established in the track prior to the POD. The nearest detector was at 49.8 km NIMT, approximately 1.6 km north of Paraparaumu and 8.2 km north of the POD. Others were located at 125.5 km NIMT (near Linton) and at 172.9 km (near Greatford). Tranz Rail advised that an additional DED at Porirua for northbound trains was under consideration at the time of the incident.

2. Analysis

2.1 The derailment

2.1.1 The first evidence of the dragging brake gear was 300 m south of Mana (at 22.5 km NIMT) where scrape marks consistent with those a dragging brake push rod would make were noted on the sleeper tops in the centre of the track. From there scrape marks became progressively heavier with damage inflicted to signal cables at 32.04 km NIMT and to turnout switch blades and spreader bars at the south/north junctions, and at Paekakariki crossing loop turnouts. The latter scrape marks were consistent with a larger bouncing obstruction such as a trailing brake beam.

2.1.2 With nothing supporting the inner right portion of the brake beam when it broke, it would have been held only by the cantilever action of the liner in the bogie frame. With no other restraint it would have vibrated out.

2.1.3 After breaking, the left portion of the brake beam would have settled in the middle until it was restrained by both the jamming of the brake beam liner in the left bogie guide and the limited restraint provided by the brake pull rod. Tapered wear on the left brake block and evidence of fretting on the mating surfaces of the left brake beam liner indicated that this section of the brake beam had been held captive in the bogie for some time after the initial failure. It was unlikely that a train examiner would have detected either the incomplete brake beam or the downward displacement of the centre of it unless he had made a detailed inspection of the underside of the wagon.

2.1.4 After an unknown length of travel in this mode, the dead load on the cantilevered portion of the broken brake beam, plus the wearing of the bogie guides, allowed the trailing end of the brake push rod to settle and make contact with the ballast section. The heavy abrasion this caused was probably sufficient to remove the split pin anchoring the clevis pin, allowing the clevis pin to become dislodged. It was likely that this occurred in the region of 32 km NIMT where the marks at sleeper top level had become more distinct.

2.1.5 With the removal of the clevis pin, the longitudinal support for the centre section of the brake beam was removed allowing it to move backwards and in so doing free itself of the cantilever support in the bogie and drop down to become in direct contact with the track. At some stage prior to the derailment (and after the pin came free) the trailing brake gear become snagged sufficient to bend the brake pull rod around the trailing axle. It was likely that it was in this position when it impacted on the spreader bar at McKays Crossing.

2.1.6 The impact on the spreader bar on the safety turnout just south of McKays Crossing bent it sufficiently to pull the facing switch blade away from the stock rail and allow a gap for a wheel to follow. In this situation the right wheels were pulled away from the rail head and the derailment ensued.

2.1.7 The locomotive event recorder output was not available for assessment and the only estimate of speed at McKays just prior to the derailment was 65 km/hour as reported by the LE. This is below the maximum allowable line speed of 70 km/h.

2.2 Brake beam failure

2.2.1 The brake beam probably initially failed by a fatigue crack initiating and propagating through the tension member adjacent to the weld between the tension member and the right-hand head casting until it failed in overload. The cracking was similar to the cracks seen in the tension member at the left side of the brake beam in the same location, which were propagating at the same time. This was where the majority of cracks had been detected in other brake beams. Once the tension member had broken, the loading on the brake beam would have significantly changed with the angle iron being subject to bending rather than compression when the brakes were applied. This was confirmed by the slight bend in the broken end of the recovered compression member. As a result of this, fatigue cracks then initiated in the angle iron at most of the welds.

2.2.2 The break in the tension member resulted from 2 fatigue cracks initiated at the edges of a weld to the central strut and on opposite sides of the tension member. Two other fatigue cracks had also developed at tack welds on either side of the tension member at the left brake shoe end. Fatigue crack striations are often present on fatigue fracture surfaces and each one is caused by an incremental advancement of the crack. The number of cycles to failure was in the order of 35 000 cycles. Braking cycles over the life of the beam would have imposed a loading of about 3000 cycles assuming a brake application on average every 10 km. It can be concluded that the fatigue cracks did not develop with each application of brakes.

2.2.3 The steel used for the failed components probably met the specified requirements (it had the correct composition and hardness).

2.2.4 The brake beam did not fail as a result of inferior welding. However, the welds used were not ideally suitable. For avoiding fatigue failure the welds should have been designed so that the section stress, the stress concentration at the edge of the weld and the residual stress levels were minimised. The single pass welds used with a narrow throat running parallel to the applied stress with significant stress concentrations at the edge of the weld did not meet this criteria. However, considering the amount of fatigue and fretting within the brake beam it is possible that a "good" quality weld might also have failed.

2.3 Brake beam history

2.3.1 The broken brake beam was likely to have been the one that was replaced on 5 November 1998 (as recorded on the Work Report/Request form) and would have therefore been in service for only 18 weeks. This length of time correlates to the age of the steel as determined from the black oxide on the surface of the tension member.

2.3.2 The earlier Work Report/Request form, dated 20 October 1998, did report a damaged brake beam, but had nothing entered on the form to indicate it had been replaced. The time of 45 minutes that had been logged for the replacement of a broken brake block indicates that this was the only attention given to the bogie and/or brake linkage at that time. The broken brake block may have been symptomatic of a fault in the brake beam that was not rectified at that stage.

2.3.3 The effects of the local intense heat created by electric welding alters the granular structure of steel and can produce local brittle hardened pockets. Comparative tests taken of the various beam components indicated that hardening had occurred at the heat affected zones adjacent to the welds. However, there was only one area (in a casting) where the hardness exceeded what was considered acceptable. This was not therefore considered to be a factor in the failure.

2.3.4 In metal fatigue situations failure can occur at stresses significantly less than that corresponding to design loading if high frequencies are involved. Examination of the failed beam showed the number of stress cycles at failure was significantly more than could be attributed to the fluctuating stresses imposed on the beam during normal braking cycles. It is possible that harmonics developed in the brake beam sympathetic to the natural period of vibration of 30 Hz, which could have been assisted by the loose and worn guides. Tranz Rail have measured high accelerations in service that are consistent with such high frequency excitation.

2.3.5 There is no written evidence that the incomplete requirements of the draft Job Breakdown Sheet dated 9 March 1999 were formalised and on hand at the time the beam was fabricated. The likely absence of any procedures may have resulted in undesirable fabrication methods and caused unnecessary stresses in welds already below desirable standards.

2.3.6 The entering and recording of wagon repair work showed inconsistencies and omissions which threw doubt on the reliability of the records. As a result, although it is likely that the brake beam concerned was replaced only once, this could not be established with certainty.

2.4 Failure implications

2.4.1 The frequency of fatigue failure in the fabricated section of Type 14 bogie brake beams indicated a general problem associated with the design details and manufacturing procedures. This had particular significance in relation to the ZH fleet, and the captive Kariori subset of this fleet, and influenced Tranz Rail's immediate safety actions.

2.4.2 The fatigue failure of a brake beam with only 5 months service is of concern. While aspects of weld detail and fabrication were less than desirable, the generally robust design of the component should have been more tolerant to such factors. It is likely that the accelerated failure of this beam was due to a combination of design and fabrication deficiencies and high frequency loading. Although the source of any such high frequency loading could not be determined, Tranz Rail in-service accelerometer readings have shown that such loadings do occur.

2.4.3 The safety recommendations made in Section 5 of this report reflect the lack of certainty as to the cause of the premature failure and the need to monitor and confirm the effectiveness of action taken following the incident.

2.4.4 The ability of loose underframe brake gear to cause significant track damage and the potential for derailment was highlighted at Hapuku (near Kaikoura) on 17 November 1998 (see Railway Occurrence Report 98-120). The incident described in this report confirms the high derailment potential associated with dragging brake gear.

2.4.5 Whilst underframe brake rodding is protected by safety straps to restrain them should they come loose, major brake components are not so protected. This places greater reliance on these components and a need for high quality control. This was not evidenced in ZH1213 brake beam fabrication.

2.4.6 A DED established in the track at any location in the 19 km prior to the POD probably would have given warning of the dragging brake gear, possibly in time to stop the train before major damage and/or injury ensued. While it is not practical to fit DEDs to detect all dragging gear, the heavy concentration of main line turnouts between Wellington and Paraparumu, which also carries commuter passenger traffic, may justify fitting this equipment.

3. Findings

Findings and safety recommendations are listed in order of development and not in order of priority.

3.1 Train 230 was being operated in accordance with Tranz Rail's operating rules and instructions at the time of the incident.

3.2 The derailment was caused when dragging brake gear fouled a spreader bar connecting 2 switch rails at a turnout, resulting in wagons taking 2 roads simultaneously.

3.3 The cause of the dragging brake gear on wagon ZH1213 was metal fatigue breaks in the tension and compression members of the trailing brake beam on the leading bogie.

3.4 The fatigue breaks propagated from the edges of welds which were outdated in design and poorly executed.

3.5 Fatigue failure should not have been initiated under normal service conditions in the life of the brake beam despite the weld detail.

3.6 The growth rate of the metal fatigue cracks in the brake beam indicate a higher cycles-to-failure figure than would normally be caused by brake application.

3.7 The source of the high cycle excitation causing premature failure of the brake beam was not identified.

4. Safety Actions

4.1 On 9 July 1999, Tranz Rail advised that all ZH wagons in the Kariori circuit had been crack tested with one beam found cracked and replaced. They stated that a visual check of the remaining ZH fleet had been completed without any further faults being found. Emphasis was placed on the ZH fleet because of their higher permitted speed and greater use. There are 4000 bogie wagons in the Tranz Rail fleet that are fitted with Type 14 bogies, of which 200 are ZH wagons.

4.2 As a result of the metal fatigue cracks found in the tension members adjacent to welding on the fabricated brake beams, Tranz Rail amended the welding detail on their plan to exclude any welding on the side of the rod and limit it to the ends of the rod only. Welding size was also increased from 5 mm to 8 mm fillets. A Job Breakdown Sheet has been formalised by Tranz Rail based on the revised plan for the fabrication of brake beams to ensure that the correct order of assembly is achieved.

4.3 Tranz Rail field staff were instructed to check the brake beams on all other wagons with Type 14 bogies as they came into a depot or had brake blocks changed. Three other brake beams had been found broken as a result.

4.4 Tranz Rail advised that overhaul procedures at both Hutt and Hillside workshops had been revised to include mandatory crack testing of all brake beams and would remain as a permanent part of the bogie overhaul process. A number of small cracks had been found at the toe of the weld on the outer end of the tension rod and all such beams had been scrapped.

4.5 As from 1 January 2000, all brake beam fabrication was limited to Hillside workshops and all such beams are now date stamped.

5. Safety Recommendations

5.1 On 6 April 2000 the Commission recommended to the managing director, Tranz Rail Limited that he:

5.1.1 issue standards and procedures to ensure that the design, construction and repair of Type 14 brake beams ensures that they are fabricated to standards to avoid excessive stresses due to the cyclic loadings envisaged, particularly those due to possible resonance (005/00); and

5.1.2 carry out service load tests on the Type 14 brake beams to confirm that the loading assumptions made to confirm fatigue life are reasonable (006/00); and

5.1.3 continue the inspection of the Type 14 bogie wagon fleet on a systematic basis to ensure the integrity of the brake beams until such time as the current frequency of failure is reduced (007/00).

Approved for publication, 12 April 2000

Hon. W P Jeffries
Chief Commissioner

Appendix 1

Job Breakdown Sheet

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REFERENCE ONLY

Date: 9/3/99

JOB BREAKDOWN SHEET FOR INSTRUCTION IN Bogie DEPARTMENT

PART: T14 BRAKE BEAM BUILD OPERATION:

IMPORTANT STEPS IN THE OPERATION A logical segment of the operation which substantially advances the work	KEY POINTS Anything in a step that might make or scrap the work, injure the worker, make the work easier to do, i.e., knack, trick, special timing or special information
Set up brake beam JIG and Check top faces are Parallell	
Place brake beam head castings on JIG	W77 ON LEFT W78 ON RIGHT
FIT TENSION MEMBER THRU HOLES IN B/B HEADS THEN FIT STRUT AND PIN IN PLACE	TAPERED FACE AND CASTING NUMBER TO FRONT ON STRUT
FIT COMPRESSION MEMBER CENTRALLY ON B/B HEADS THEN ALIGN HEADS WITH INNER FACES OF JIG	
FIT WEDGES THRU B/B SKEWER HOLES AND CLAMP TO JIG	
TACK WELD TENSION AND COMPRESSION MEMBERS IN POSITION	USE WELDING PROCEDURE XXXX
WELD END OF TENSION MEMBER TO B/B HEAD, COMPRESSION MEMBER TO B/B HEAD AND TENSION MEMBER ~~TO B/B HEAD ON INNER FACE~~	WELD IN POSITIONS AS MARKED ON DRAWING XXXX
REPEAT FOR RIGHT HAND END	
ROTATE JIG SO TENSON ~~MEMBER IS AT TOP.~~	

A1 2of2 2/2

REFERENCE ONLY

Date:..................................

JOB BREAKDOWN SHEET FOR INSTRUCTION IN .... DEPARTMENT

PART:.................................... OPERATION:....................................

IMPORTANT STEPS IN THE OPERATION A logical segment of the operation which substantially advances the work	KEY POINTS Anything in a step that might make or scrap the work, injure the worker, make the work easier to do, i.e., knack, trick, special timing or special information
TACK STRUT IN POSITION AT TOP AND BOTTOM	ENSURE IT IS CENTRAL AND NOT TWISTED
WELD LEADS TO COMPRESSION MEMBER IN 4 POSITIONS	
WELD STRUT IN 2 POSITIONS TO TENSION MEMBER	
WELD BASE OF STRUT TO COMPRESSION MEMBER	ONLY 1 WELD POSSIBLE WHILE IN JIG.
REMOVE FROM JIG THEN WELD STRUT TO COMPRESSION MEMBER.	
CHIP SLAG FROM WELDS AND VISUALLY INSPECT.	
MARK STRUT WITH ORANGE PAINT TO IDENTIFY AS METRIC	