Report 98-120

Train 700

dragging brake gear

Hapuku (near Kaikoura)

17 November 1998

Abstract

On Tuesday, 17 November 1998, at approximately 1040 hours Train 700, the northbound *Coastal Pacific* passenger express, was travelling through Hapuku when dragging brake gear on a high speed goods wagon at the head of the train struck and damaged the main line turnouts. The train continued for a further 26 km before the locomotive engineer noted track ballast being thrown up by the dragging brake gear and stopped the train.

Dragging brake gear had the potential to damage facing turnouts to the extent that the points could move under a train and direct part of the train to a different route. Any such diversion of part of a passenger train had a high probability of leading to a serious derailment.

Safety deficiencies identified were the inadequacy of the brake rodding safety straps and the failure of Tranz Rail Limited's safety system to prevent or detect dragging brake gear creating a danger to crew and passenger safety. Two safety recommendations were made to address these deficiencies.

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Glossary of abbreviations

DED	Dragging equipment detector
LE	locomotive engineer
Tranz Rail	Tranz Rail Limited
MNL	Main North Line
TXM	train examiner maintenance

Transport Accident Investigation Commission

Rail Incident Report 98-120

Train type and number:	Passenger Express 700
Date and time:	17 November 1998, 1040 hours
Location:	Hapuku, 10.5 km north of Kaikoura, at 200.77 km Main North Line
Type of occurrence:	Dragging brake gear
Persons on board:	Crew : 3 Passengers : 71
Injuries:	Nil
Nature of damage:	Damage to the hand brake gear on HKP 74 and to four turnouts Two broken car windscreens
Investigator-in-Charge:	R E Howe

1. Factual Information

1.1 Narrative

1.1.1 On Tuesday ,17 November 1998, Train 700 was an express passenger train travelling between Christchurch and Picton. The consist was locomotive DX5206, two express goods wagons HKP74 and ZH2051 and five passenger cars, A3022, AG182, AO221, AO238 and AS207. On board were a locomotive engineer (LE), two train staff and 71 passengers.

1.1.2 At about 1040 hours as the train was passing through Hapuku, at 200.77 km Main North Line (MNL) and 10.5 km north of Kaikoura, the leading end of a brake rod[1] impacted on the control gear of the main line turnouts at each end of Hapuku loop. The LE estimated the train speed at Hapuku was 90 km/h, the maximum allowable line speed. The train crew were unaware of the dragging gear and the train continued on its journey.

1.1.3 Between 201.5 km and 203 km MNL, track ballast thrown up by the dragging gear broke the windscreens of two cars that were travelling on the adjacent state highway and caused other minor damage. There were no injuries to the occupants of the cars.

1.1.4 The LE stated that his first indication that something was wrong was when he noticed ballast being thrown up at approximately 226 km MNL. He stopped the train and on inspection found that part of the brake rigging on the rear bogie of wagon HKP74 had collapsed and was dragging on the track.

1.1.5 The LE's inspection found that the clevis[2] bolt intended to fix the front of the brake rod to the front brake lever arm was missing and the rod disconnected. The rod had been bent and displaced into a trailing position but was still fixed to the rear brake lever arm. This lever arm had been bent backwards about the brake beam fork assembly pivot and had fractured, allowing the arm to come free of the assembly and be attached only by the top arm fixing. Figure 1 shows the recovered components

1.1.6 The edges of the front brake rod clevis had become worn away where it had trailed over the track ballast (see Figure 2). The clevis bolt fixing the rear brake rod clevis to the rear lever arm had been gas cut off flush with the outside of the nut (see Figure 3).

1.1.7 The front brake lever arm had not been located by the brake beam fork assembly and the brake pull rod had dropped down so that it was bearing on the leading axle of the bogie causing heat blueing (see Figure 4).

1.1.8 The LE withdrew the two top clevis pins to each of the brake lever arms. The withdrawal of the rear pin allowed the removal of the bent rear lever arm which was still attached to the brake rod. The withdrawal of the front pin allowed the removal of the front brake lever arm from the brake pull rod and the lever arm came away with the brake beam assembly pivot attached to the centre of the lever arm (see Figure 1).

1.1.9 The LE stated that he did not touch the pin that located the front brake beam fork assembly into the brake beam. He noted that this pin was still in place although the split pin at the bottom was missing. Figure 5 shows the pin still in the brake beam housing as it was described by the LE.

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[1] unless otherwise stated all references to brake rods in this report refer to brake push rods.

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

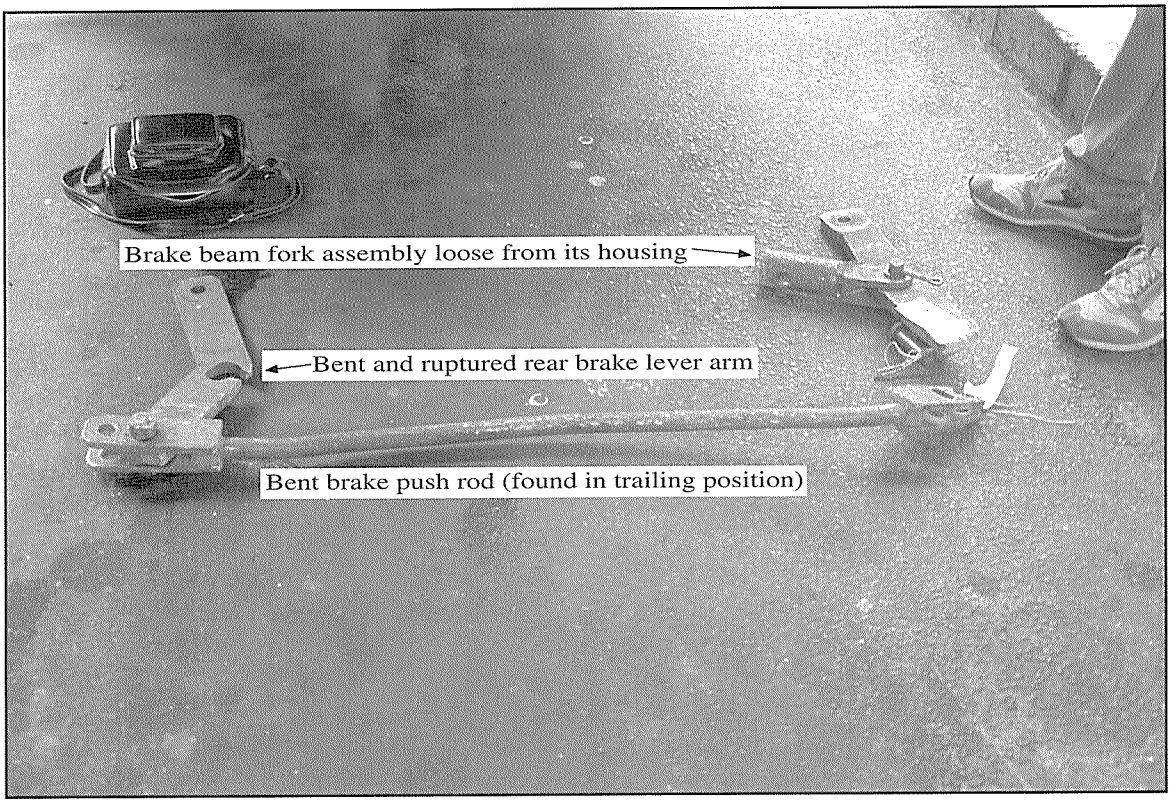

Figure 1
Recovered hand brake components

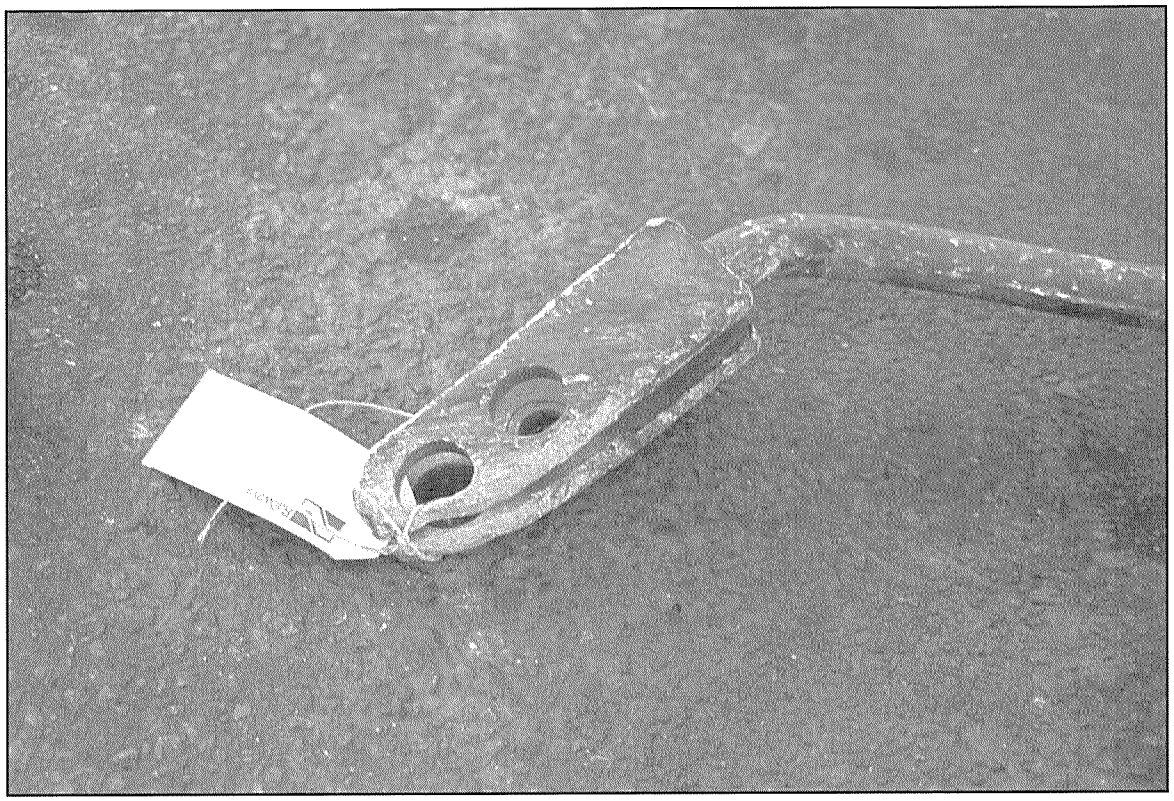

Figure 2
Front brake rod clevis (note wear resulting from trailing over ballast)

Figure 3
Rear brake rod clevis (note the gas cut marks on the end of the bolt)

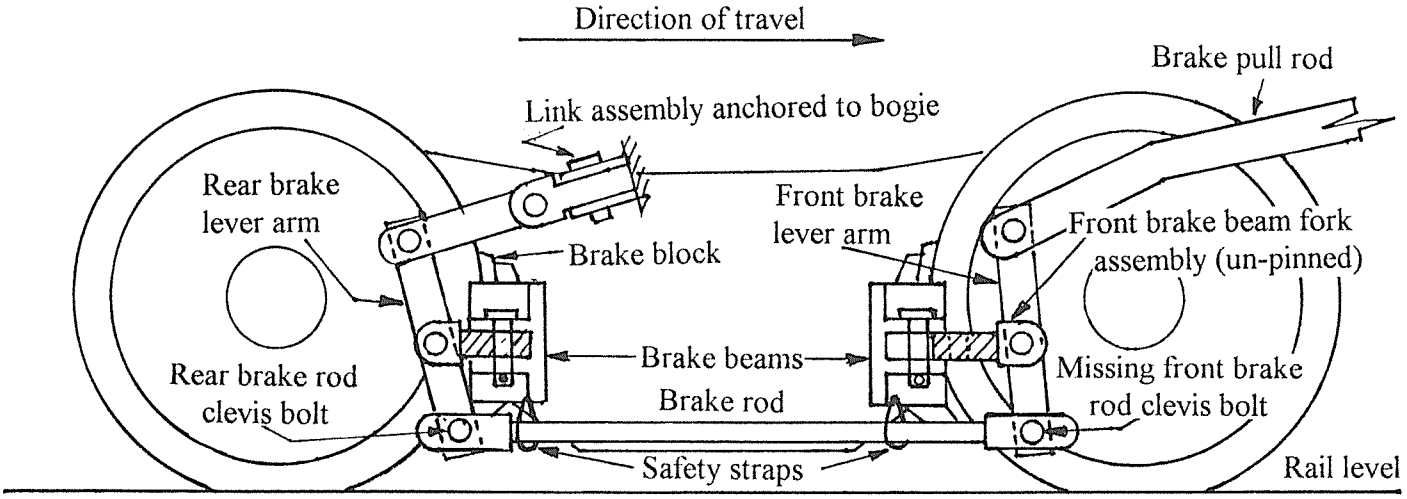

Figure 4
Diagrammatic section of the rear bogie showing hand brake gear (the front brake beam fork assembly is shown un-pinned in the housing)

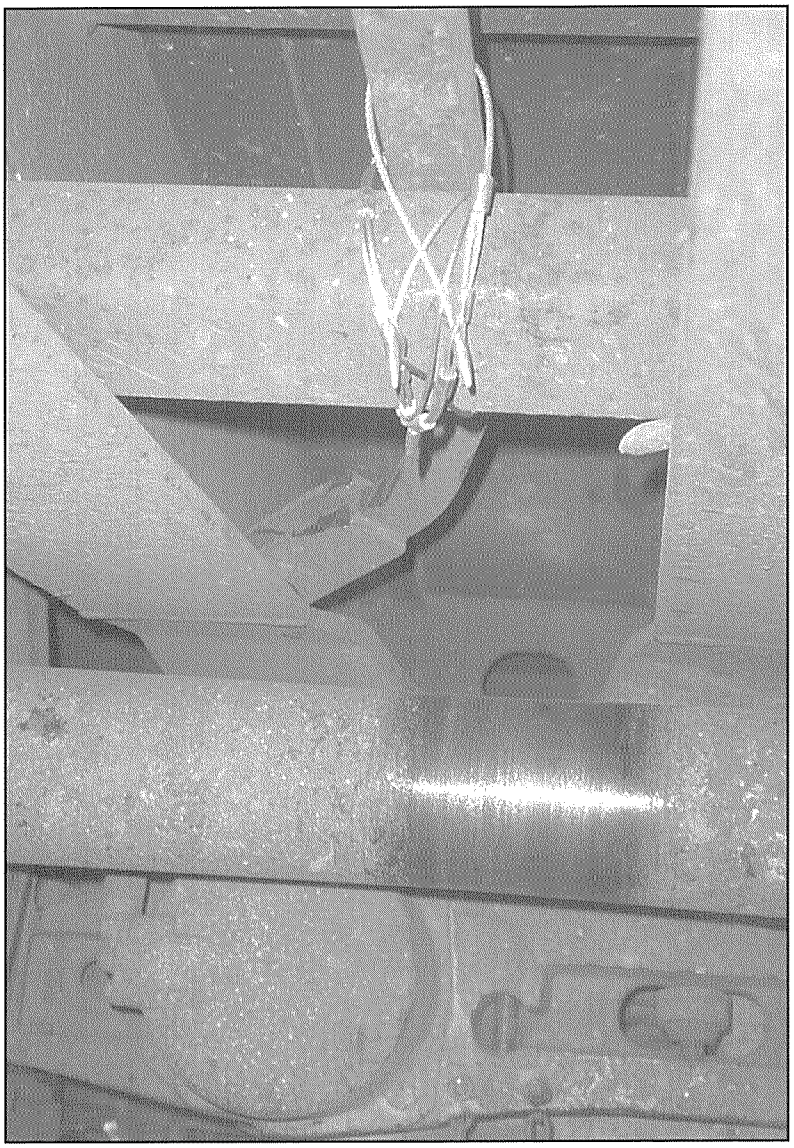

Figure 5
Axle and brake beam

blueing marks on the axle where the brake pull rod was making contact

the housing in the brake beam to take the fork assembly with the locating pin still in position (as found)

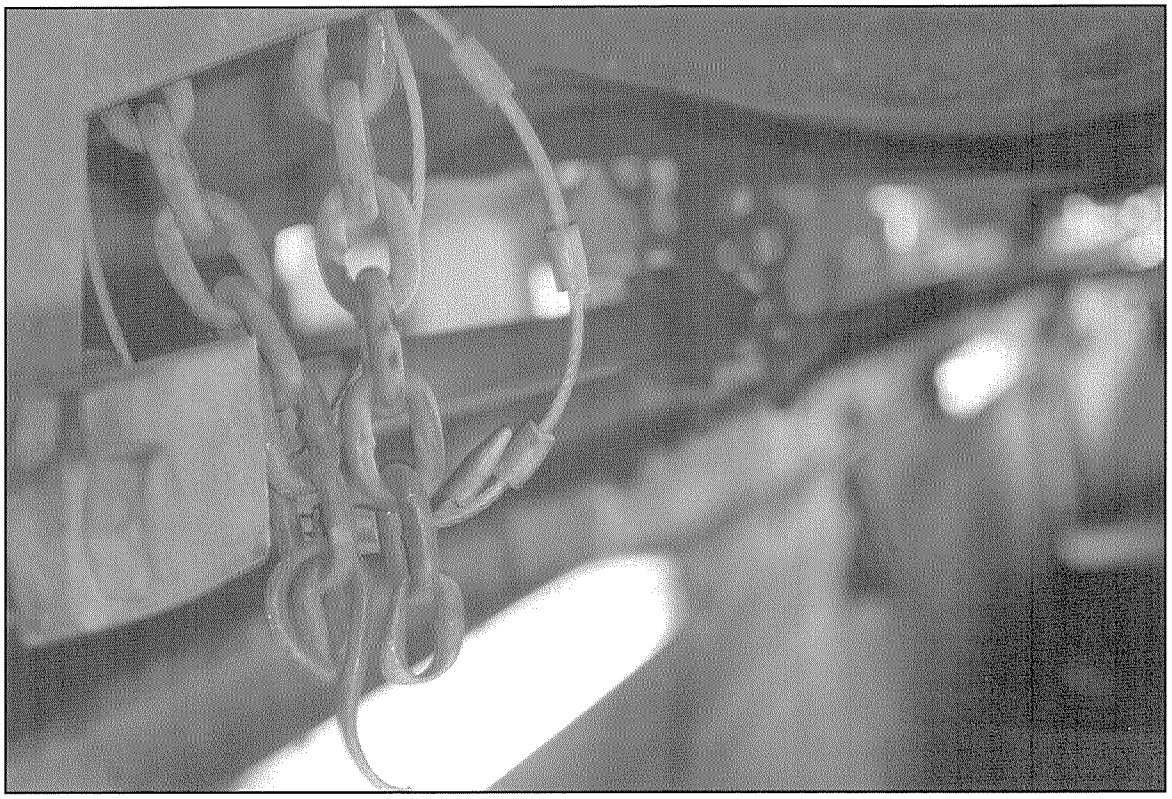

Figure 6
Safety strap
(note the previously used safety chain with worn links)

1.1.10 After removing the dragging brake gear the LE drove the train to Parikawa (235.54 km MNL) at slow speed. At Parikawa wagon HKP74 together with the following wagon ZH2051 were detached. ZH2051 was detached because it showed evidence of abrasion marks on the wheels due to running over track ballast thrown up by the dragging brake gear on HKP74.

1.1.11 The wagons were inspected by the Train Examiner on the day following the incident and the uncoupled hand brake gear on wagon HKP74 was secured so that the wagons could be forwarded to Auckland for discharge.

1.2 Track damage

1.2.1 The spreader bar on the facing south end turnout at Hapuku had been bent down by recent impact. A frayed wire strap, used as a safety strap for the brake rodding, was found adjacent to the turnout.

1.2.2 Recent marks on the closure rail of the trailing turnout at the north end of Hapuku indicated that it had been hit just to the right of track centre line before the obstruction had been deflected further to the right before striking the control gear at the point of the switch. The damage to the control gear was so severe that the actual impact point could not be defined. The spreader bar was taken out with the impact together with the associated switch locking mechanism. A second brake rod[3] safety strap that had been wrenched from its fixings was found adjacent to the turnout.

1.2.3 The drive rods to both the main line turnouts at Pines approximately 20 km north of Hapuku at 220.87 km MNL were bent and showed signs of recent impact.

1.2.4 Subsequent examination of the Old Beach Road level crossing at 198.96 km MNL revealed a fresh 300 mm long score mark in the southern edge of the tar seal. The seal was at rail level. There was no evidence of dragging gear at the first sealed crossing south of Old Beach Road at 198.26 km MNL.

1.3 Wagon bogies

1.3.1 The bogies on wagon HKP74 were Type 16A "(Sheffell"). A feature of this bogie type was that all the power brake actuating mechanism was carried on the bogie. The brake shoes could be operated by either the train brake system or the hand brake mechanism independently.

1.3.2 With this bogie system, worn brake blocks were replaced by levering the brake beams away from the wheels to obtain sufficient clearance to fit new brake blocks. Adjustment was then taken up automatically to compensate for brake block wear. On more conventional and common bogies (type 14 and 16) clearance to fit new brake blocks was intended to be gained by winding back the slack adjuster on the wagon. However, maintenance staff stated that it had been known for staff to remove the bottom pin on Type 14 bogies to get maximum clearance for replacing brake blocks.

1.3.3 The hand brake system was operated by a hand wheel which tightened a chain linkage to brake pull rods for each bogie. The brake pull rod was connected to the top end of a lever arm which was linked to a fork assembly in the middle of the arm and the brake rod at the bottom. With the application of the hand brake, the action and reaction of the forces on these two pivots caused the brake beams to be forced apart and apply the brakes to each set of wheels. Under normal situations the hand brakes could be applied with two full turns of the hand wheel.

1.3.4 As indicated in Figure 4, the front brake beam fork assembly on HKP74 was only partially located in the brake beam housing. The 140 m long by 25.6 mm diameter locating pin was in position in the brake beam but not locking in the fork assembly (see Figure 5). The bottom split pin was missing from the locating pin.

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[3] each brake rod had two safety straps fitted as shown in Figure 4

1.3.5 The brake rod fitted to HKP74 following the incident had a measured clearance of 60 mm above rail level. An inspection on 17 October 1998 had recorded a tyre depth of 40 mm on the wheels of HKP74. Under Tranz Rail's standards for maximum allowable wheel reprofiling and wear the depth could be reduced further down to 16 mm which would have resulted in a minimum clearance of 36 mm above rail level.

1.3.6 Tranz Rail recognised the potential for the brake rods to cause significant damage should they come loose and provided safety straps on all rodding. Chain links were originally used but because of the friction wear on the bottom links, safety straps had been introduced some two years ago. A safety strap was found adjacent to each of the turnouts at Hapuku. The straps consisted of a pair of 3.4 mm diameter woven stainless steel cables crimped together at 55 mm spacing and capable of being adjusted in length to loop around the brake push rod and be fixed through a pair of holes in the underside of the brake beam. Figure 6 shows a similar safety strap fitted to the brake rod on the leading bogie of HKP74. Also visible is the disconnected chain system that had been used, together with evidence of friction wear to the bottom links.

1.3.7 The slack in the safety straps on the affected bogie was not able to be determined because of the damage to the brake rod and the straps. Typical clearances of 40 mm were measured on other similar wagons. Maintenance staff stated that they were aware of the need to keep the slack to a minimum consistent with not binding on the brake rods. Tranz Rail had no instructions or operating procedures detailing the amount of slack permitted when fitting safety straps.

1.3.8 Until approximately 15 months prior to this incident, all clevis brake rod fastenings on the "Sheffell" bogie were fitted with pins and retained by a split pin. However because of the susceptibility of the split pin to work free Tranz Rail issued an instruction in 1997 requiring that all brake push rods clevis pins were to be replaced with nuts and bolts. To ensure that the nuts did not work loose from the bolt, they were to be welded to the bolt with two tack welds each 15 mm long. Wagon HKP74 had been modified in this manner.

1.3.9 The front clevis bolt to the brake rod was missing at the time the defective brake gear was removed from the wagon by the LE and a search of the track leading up to Hapuku failed to find it. The rear clevis bolt was in place but the thread had been gas-cut off flush with the head of the nut. The nut was able to be rotated slightly by hand but was held from coming undone by burrs on the thread caused by the gas cutting (see Figure 3).

1.4 Wagon history

1.4.1 Wagon HKP74 was one of a small fleet of special wagons that had been certified to run at maximum authorised speeds with express passenger trains.

1.4.2 To validate the certification, the wagons were required to undergo a special inspection every 20 000 km. The monitoring and inspection of all such wagons was the responsibility of the Service Manager Wagons, Dunedin. If a wagon exceeded the stipulated distance between inspections, the wagon was permitted to run only in goods train traffic until recertified at the Dunedin Depot.

1.4.3 The dates of the of the last three inspections for HKP74 were:

7 August 1998

19 October 1998

10 November 1998

and there had been no need to restrict the running of this wagon.

1.4.4 At the 10 November Inspection the following work was recorded as being carried out on wagon HKP74 at Dunedin Wagon Repair depot:

> . . . check and oil twist locks. Replace rigging pin with bolt. Airtest (and) fix leak at UTA piping. 3 safety straps. Replace split pins in rigging.

Details of the exact positioning of the rigging pin replaced was not recorded, nor the positions of the replaced split pins. The locations of the three safety straps which were replaced were not detailed.

1.4.5 The Fleet Maintainer, Wagon Repair who carried out the work on HKP74, gave the final check to the wagon before it went back out into service. The check included the proper functioning of brakes, including the operation of the hand-brake wheel. He completed the work-sheet for the wagon and advised Operations that it was ready to go out.

1.4.6 Although random spot checking of completed wagons was a requirement carried out by the Service Manager, Wagon Repair, HKP74 was not one of the wagons picked up by this procedure.

1.4.7 It was usual for the Team Leader to also carry out random checks on wagons but this position was vacant at the time due to an amalgamation of plant and wagon staff.

1.4.8 The brake blocks were not renewed at the time of carrying out the 10 November inspection. No historical data was available to ascertain brake block life on a wagon in service. On 10 November there was no indication on the brake blocks that they needed renewing. However it was not possible to establish the amount of life left in them when they left the depot. Inspection after the incident showed that HKP74 had recently renewed brake blocks. The Tranz Rail Asset Manager advised that the replacement of brake blocks was such a regular maintenance operation that it was not recorded unless it was part of a bigger inspection / maintenance operation.

1.4.9 The staff authorised to carry out brake block replacement were train examiner maintenance (TXMs) or fitters associated with TXMs. The team usually consisted of two men. Between the last inspection on 10 November 1998 and the incident on 17 November 1998 the only centres where HKP74 stopped long enough for TXM teams to work on the wagon were Auckland and Dunedin. Subsequent enquiries failed to find any record or recollection of any such work having been undertaken at these, or any other localities.

1.4.10 Since the 10 November inspection, the wagon was waybilled for the following destinations :

11/11/98	Dunedin to Auckland
13/11/98	Auckland to Dunedin
17/11/98	Dunedin to Auckland

1.5 Personnel

1.5.1 The Service Manager of the Dunedin Wagon Depot had 20 years experience with railways, all in Dunedin. He started in the Diesel Depot in Dunedin before completing an adult fitter and welder apprenticeship and then an apprenticeship as a Loco Maintainer. He had four years experience as the Team Leader at the Dunedin Wagon Depot before passing the Level 5 Plant Maintenance and Loco Maintenance examination and promotion to the Service Manager, Wagons. He had held that position for three months prior to the incident being examined by this report, and was also carrying out Team Leader duties on 10 November 1998.

1.5.2 The Fleet Maintainer, Wagon Repair had a total of 14 years railway experience. He started with New Zealand Railways in Dunedin in 1980 as a fitter (wagon repairer) for five years before qualifying as a Train Examiner (maintenance). He left in 1991 and rejoined Tranz Rail in 1996 as a Fleet Maintainer.

1.6 Dragging equipment detection

1.6.1 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. There are currently 29 such installations on Tranz Rail and a further 34 are proposed, including one at Ferniehurst (150.0 km MNL) and one at Kaikoura (193.75 km MNL).

1.6.2 The closest DED south of Hapuku was at Scargill, at 85.14 km MNL. This was not activated by Train 700 on 17 November and there was no activation of any DEDs on the route of HKP74 between 10 November and 17 November.

2. Analysis

2.1 The sequence of events leading to the dragging brake gear is not clear. The likely scenario is that the front fork assembly that was not properly located and pinned into the brake beam had completely dislodged under normal wagon movement in transit. This resulted in the vertical support being taken entirely by the front safety strap. In this situation the safety strap was taking the dead load of not only the brake rod but also the brake lever arm, the fork assembly and the rear portion of the brake pull rod.

2.2 The load on the safety strap would have exacerbated abrasion due to contact with the ballast and other obstructions and exposed the brake rod clevis to abrasion from ground contact. In this position the brake pull rod would not have been lowered sufficiently to bear against the axle.

2.3 The gas-cut removal of the bolt end on the trailing clevis was likely to have been done to remove weld fixing, although no evidence of the weld fixing remained.

2.4 The lowered position of the leading brake rod clevis exposed the front nut and bolt to abrasion and allowed them to work loose so that the brake rod became disconnected from the lever arm. This allowed the brake pull rod to drop down so that it was supported at the rear by bearing on the axle.

2.5 The missing leading brake rod clevis bolt was not found. It is reasonable to assume that, like the trailing bolt, it had been gas cut off and that abrasion allowed the nut to work loose and the bolt to vibrate out.

2.6 It was not possible to ascertain where or by whom the last work on the hand brake gear to the rear bogie on wagon HKP74 had been carried out which resulted in the ends of the push rod clevis bolts being gas cut off and the front brake beam fork assembly removed from its housing and replaced without being properly pinned. There are three possibilities :

- that the brake gear was in that condition when it passed out of the Dunedin Wagon Repair Depot on 10 November
- that subsequent work (possibly to replace worn brake blocks) had been carried out in the field by staff who were not familiar with the "Sheffell" bogie features and the job was not completed before the wagon was put into service again
- vandalism.

Dealing with each in turn:

2.6.1 The staff at the Dunedin Wagon Repair Depot were well conversant with the particular peculiarities of the "Sheffell" bogie. The depot monitored the small high speed wagon fleet and carried out all necessary maintenance. They stated they had replaced the brake rod pins with bolts and nuts and they had no subsequent need to gas cut the bolts off. There was no work on the wagon that required them to remove the pull rod nuts and bolts, nor to remove the brake beam fork assembly. The displaced brake beam fork assembly would have prevented the hand brake from being effectively applied and would have shown up in the final check out of the wagon. It is unlikely that HKP74 left the Dunedin Wagon Depot with the defects found following the incident.

2.6.2 In the event of a train examiner operations detecting worn brakes on any wagon in service it was normal for the brake blocks to be replaced in the field by qualified TXM teams. Staff not familiar with the method of replacing brake blocks on "Sheffell" bogies, may have believed it was necessary to remove the pull rod clevis bolts in order to space the old brake blocks away from the wheels before fitting the new blocks. No explanation can be given for the need to pull and separate the fork assembly from the brake beam and then replace the assembly without correctly locating and pinning it. Based on the reports of the Auckland and Dunedin TXM staff and the standard of the brake gear it is likely that the sub-standard hand brake gear was caused by incorrect and incomplete field work carried out by Tranz Rail staff.

2.6.3 The possibility of vandalism is considered remote when considering the complexity of the actions taken.

2.7 The following are the likely brake rod clearances to rail level at various amounts of wheel wear:

Amount of wheel wear	Brake rod clearance above rail level
0 mm	90 mm
30 mm	60 mm (as measured on HKP74)
54 mm (max. allowable)	36 mm

The effect of the brake rod bearing on the safety strap would have taken all of the slack out of the strap. The 30 mm wheel wear on HKP74, assuming a nominal 40 mm slack in the safety strap, would have resulted in a 20 mm clearance between rail level and the underside of the brake rod. However the marks on Old Beach Road crossing and the frayed nature of the wire safety strap found at the turnout at the south end of Hapuku suggests that the slack in the safety strap was more than 40 mm and that it allowed the brake rod to drop considerably lower. As a result the safety strap would have been subject to accelerated frictional wear from track bed interaction, particularly at level crossings.

Assuming maximum allowable wheel wear and the same 40 mm slack in the safety strap, brake rods would have dropped to 4 mm below rail level before being restrained. This would have resulted in marginal clearance from possible obstructions in such circumstances.

2.8 The score mark at Old Beach Road level crossing at 198.96 km MNL indicated that the brake rod was below rail level at that point. The lack of markings over the full width of the level crossing would have been due to the brake rod bouncing up after impacting the edge of the seal.

2.9 At the south end of Hapuku the front end of the brake rod was low enough to strike the spreader bar of the main line turnout. The height of the spreader bar before impact is not known but would have been below rail level. It is possible that the impact at Old Beach Road Crossing initiated safety strap failure allowing the brake rod leading end to drop below rail level, and that the failed strap was dislodged by the impact at Hapuku. Such an impact at a facing turnout had the potential to open the switch points and allow the following wagons or carriages to derail.

2.10 At the north end of Hapuku the front end of the brake rod struck the curved closure rail of the turnout and the rod was deflected to the right side. The brake rod then fouled the spreader bar and interlocking gear with sufficient impact to cause the rod to be wrenched backwards and pivot about the rear brake rod clevis. In doing this the rear brake rod safety strap parted under tension and was torn from its fixing on the brake beam. The force of the rearward wrench of the brake rod was sufficient to bend back the rear brake lever arm about the fork assembly pivot, rupturing the arm at that point and freeing it from the fork assembly.

2.11 North of Hapuku the brake rod was in a trailing position and inflicted only minor damage to the turnout control gear at Pines.

2.12 The trailing brake rod dragged on the ballast section for approximately 26 km and resulted in wear on the clevis. The ballast thrown up by this dragging caused the broken windscreens on road vehicles on the adjacent state highway.

2.13 Analysis of waybills showed the distance travelled by HKP74 from the inspection of 10 November 1998 at Dunedin until the incident at Hapuku on 17 November was approximately 3300 km, i.e. within inspection guidelines.

2.14 Tranz Rail's proposed DEDs for future installation included:

Ferniehurst	150.00 km MNL
Kaikoura	193.75 km MNL

Either of these may have detected dragging gear on Train 700 depending on where the safety strap failed. An increase in DEDs will reduce, but not eliminate, the possibility of accidents due to dragging equipment such as brake rodding.

2.15 Although the evidence available does not permit the sequence of events to be reconstructed with confidence, the events which led to the incident, and a possible accident, had a common feature, i.e. the failure of the safety straps to restrain a fallen rod until inspection permitted repairs to be carried out. Tranz Rail's programme of DED installations, coupled with improved locking details, will reduce, but not eliminate, the possibility of accidents due to dragging gear Effective safety straps are a key component in the overall defence against such accidents.

3. Findings

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

3.1 The dragging brake gear on HKP74 was due to the sub-standard assembly of the brake gear.

3.2 It is likely the sub-standard assembly arose from unnecessary and incomplete work carried out in the field by Tranz Rail staff, possibly in association with brake block renewal.

3.3 The sub-standard assembly resulted in the brake rod dropping and being restrained by the safety straps.

3.4 The leading safety strap did not perform its intended function and was abraded by ground contact.

3.5 The failure of the safety strap allowed the brake gear to fall low enough to impact on turnout control gear.

3.6 The impact with the turnout control gear had the potential to derail Train 700 at high speed.

3.7 The Tranz Rail safety system including:

- brake gear security detail and the quality control of repairs to brake gear
- safety straps to restrain dragging brake rods
- DEDs to minimise the hazard associated with dragging equipment

failed to avoid damage to the control gear of main line turnouts which had the potential to cause a major derailment.

3.8 The lack of standards for slack in safety straps to ensure a minimum height above rail level was maintained was a major contributor to the incident.

3.9 The inspection requirements for wagons authorised to run on passenger trains had been met.

4. Safety Actions

4.1 As a result of the incident Tranz Rail issued the following instruction on 23 November 1998 requiring modifications to the hand brake system on HKP wagons to prevent the loss of brake push rods due to pins falling out. This instruction extended a 1998 instruction which applied to only the brake push rod pins on wagons with Type 14, 16 and 18 bogies, including all derivatives.

> **Instructions**:
> Replace all handbrake pins as quoted on drawing 11050309 - "items H & J" with bolts and nuts. This is to include the "Banana Bar"[4] pull rod attachment.
>
> The nut is to be welded to the bolt using 2 x 15 mm long tacks, 180° apart so that the bolt has minimum free play but is still free to rotate in the hole.
>
> Note that these bolts are only to be removed to adjust the brake rigging after a wheel turn, replacement of wheelsets or when given a complete overhaul.
>
> Record all wagons as they are modified by recording this FMI on the SAP computer system.
>
> All wagons affected are to be modified as they pass through Depots, Field units, etc. This work is to be regarded as top priority to ensure that the current set up is not a contributing factor in derailments.

5. Safety Recommendations

5.1 On 26 March 1999 it was recommended to the Managing Director of Tranz Rail that he:

5.1.1 Issue standards and procedures to ensure that safety straps effectively restrain loose brake rodding gear clear of all obstructions within the permitted tolerances associated with rolling stock / track interaction (003/99); and

5.1.2 Ensure only trained and certified staff are permitted to carry out field repairs / adjustments to the running gear of wagons authorised to run on high speed passenger trains, and that all such repairs are recorded (004/99).

5.2 On 29 March the Managing Director of Tranz Rail responded as follows:

5.2.1 Recommendations 003/99 and 004/99 have been adopted and are currently in the process of implementation.

Approved for publication 31 March 1999

Hon. W P Jeffries
Chief Commissioner

[4] the "Banana Bar" pull rod is the brake pull rod attached to the top of the front brake lever arm. The bend at the end of the linkage provided clearance to the axle and the pull rod was commonly referred to by this term.