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10 December 2012

Your reference: M326008

Our reference: M076-22L12-D5-YM8972C-SpecialistInspection

MSIG Insurance (Singapore) Pte Ltd
16 Raffles Quay
#24-01 Hong Leong building
Singapore 048581

Attention: Ms Eng Huey Ni

Tel: 6643 1314/ 6643 1330, Fax: 6643 1349

Dear Ms Eng,

SPECIALIST INSPECTION REPORT:

YM8972C - Havi Logistics (S) Pte Ltd - Insured vehicle hit 3 pedestrians on 6/11/2012

Thank you for using KOAYS CONSULTING PTE LTD.

This report addresses the results of our specialist inspection/ investigation of the Insured vehicle YM8972C on 23 November 2012, and determines if there were any defects or deficiencies at the material time that could have caused or contributed to the accident.

Please refer to the attached report for details.

If you have any questions, or if you need any additional information, please do not hesitate to call me at 94512866. I can also be reached via email at koays.ar@gmail.com.

Yours faithfully

Er. Kelvin Koay
Principal Forensic Consultant



Your reference: M326008

Our reference: M076-22L12-D5-YM8972C-Brakes

SPECIALIST INSPECTION REPORT

Specialist inspection/ investigation of the Insured vehicle YM8972C on 23 November 2012; determines if there were any defects or deficiencies at the material time that could have caused or contributed to the accident.

REPORT DATE: 7 December 2012

For:

MSIG Insurance (Singapore) Pte Ltd
16 Raffles Quay
#24-01 Hong Leong building
Singapore 048581

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Insured: Havi Logistics (S) Pte Ltd

Police Report dated 9/11/2012: Lorry- Pedestrian accident along Clementi Avenue 6 on 6/11/2012. (See Appendix 1 for details)

1. Assignment:

- 1.1 On 22 November 2012, KOAYS CONSULTING PTE LTD received this assignment from Ms Eng Huey Ni of MSIG Insurance (Singapore) Pte Ltd.
- 1.2 The scope of this assignment was to:
 - a) Inspect the vehicle's brake system that could or could not have compromised the brake efficiency of the vehicle;
 - b) Investigate why there was a need to do a brake test the day before the accident;
 - c) Investigate what was done after the brake test – any replacement of parts; and
 - d) Investigate whether there was any problem with the brake system of the vehicle.

2. Background:

- 2.1 The insured vehicle ¹YM8972C is a Goods Refrigerated Vehicle first registered in 29 August 2008.
- 2.2 It is owned by Havi Logistics (S) Pte Ltd and is maintained by Tan Chong Industrial Machinery (Pte) Ltd (TCiM).
- 2.3 The vehicle was involved in a road traffic accident along Clementi Avenue 6 in the direction towards PIE at the signalised traffic junction of Clementi Avenue 6 and Clementi Loop at about 6:25 pm on 6 November 2012. It collided into three pedestrians who were crossing the road at the material time.
- 2.4 The driver, Mr. Sun Xin Jian ²reported that he was then travelling at about 50 km/h when suddenly the traffic light turned red, but when he tried to brake his vehicle, its brake was not efficient and as such he could not brake in time.
- 2.5 Mr. Sun added that in order to reduce his speed, he tried to steer his vehicle to the right and went up the divider, but however, there was a traffic light in the way; and that to avoid the traffic light pole, he swerved his vehicle back to the left where he hit the three pedestrians crossing the road.

3. Investigation/ Specialist Inspection:

- 3.1 A specialist inspection was conducted on vehicle YM8972C on 23 November 2012 at Tan Chong Industrial Machinery (Pte) Ltd, 23 Jalan Buroh, Singapore 619479.

¹ Appendix 2: Vehicle details

² Appendix 1: Police Report



- 3.2 The inspection jobs were carried out from 10 am to 4 pm on 23 November 2012, and encompassed the following areas that have been assessed relevant to the accident:
- a) General condition survey of the vehicle;
 - b) Check and evaluation of the vehicle maintenance records;
 - c) Brake static tests;
 - d) Brake operational tests, both on the road and at the STA Vehicle Inspection Centre, and
 - e) Inspection of the condition of brake parts in the vehicle.

- 3.3 An interview was also conducted with the driver on 29 November 2012.

General condition survey of the vehicle

- 3.4 Odometer reading of 99495 km for a 4-year plus old vehicle is reasonable.
- 3.5 Its overall condition and upkeep may be described as fairly poor. Nevertheless, its steering system was found in serviceable condition.
- 3.6 Certain body parts were corroded, bent and distorted, e.g. under-ride side protection guard-rails, rear bumper, driver-side floor panel, etc. See Photos 1 to 25, and 28.
- 3.7 The rear tyres were worn down to the legal minimum limit of 1 mm tread depth, and their outer side-wall canvass exposed. See Photos 7 to 11, 13 to 15, and 20 to 25.
- 3.8 Accident damage appeared to have been sustained to the following parts:
- a) Front corner panel rhs – dented, grazed;
 - b) Front corner panel garnish rhs – missing;
 - c) Signal light rhs – broken;
 - d) Front bumper – dented;
 - e) Front bumper corner rhs – distorted, grazed;
 - f) Front door rhs – grazed;
 - g) Front door rhs signal light – broken;
 - h) Lower step rhs – missing; Lower step garnish rhs – torn
 - i) Front number plate – dented;
 - j) Front grille logo – indented;
 - k) Front bumper corner lhs – shifted;
 - l) Front corner panel lhs – dented;
 - m) Front corner light cover lhs – cracked;
 - n) Front door lhs – slightly grazed;
 - o) Lower step plate lhs – broken; Lower step garnish lhs – torn.



Photo 1: Front view of vehicle



Photo2: Front bumper, front number plate and front grille dented.



Photo 3: Front bumper corner rhs, corner panel rhs, and right signal light damaged.



Photo 4: Lower step plate, garnish lhs broken, torn.

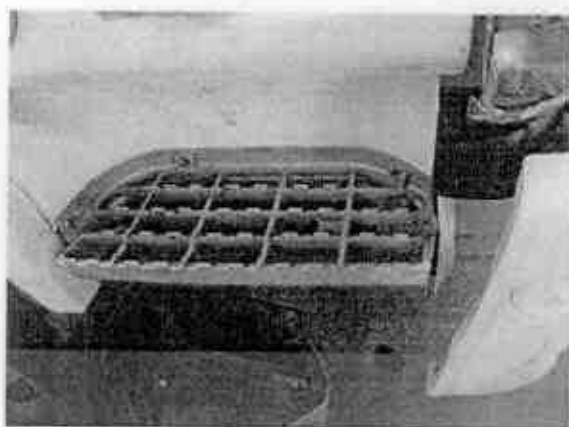


Photo 5 Lower step plate, garnish rhs broken, torn.



Photo 6: Side guide rail rhs bent.

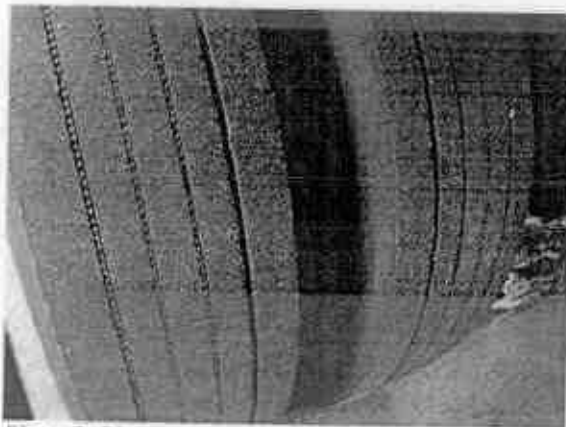


Photo 7: Rhs rear tyres.

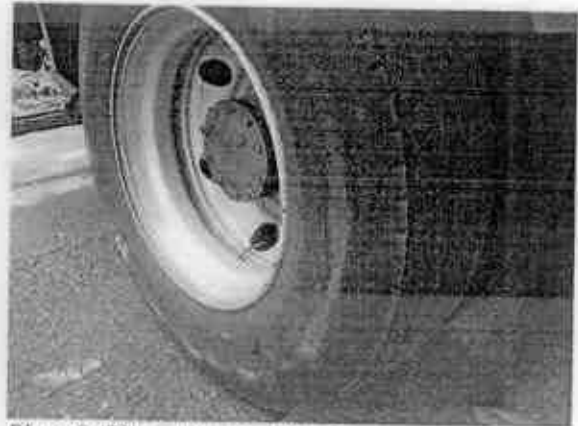


Photo 8: Rhs rear tyres side wall.



Photo 9: Closer view of the tyre wall.



Photo 10: Another view of the side wall rear tyre.

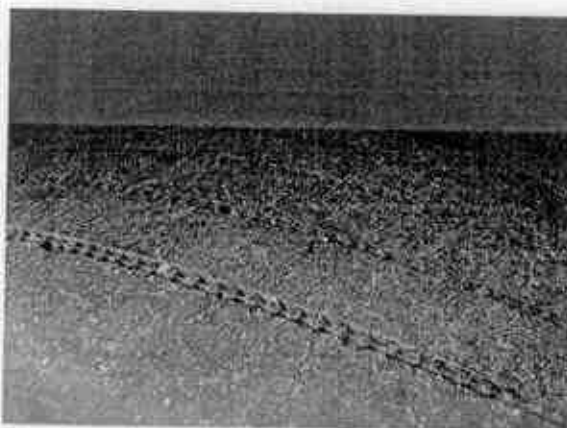


Photo 11: Another closer view of the rear tyre.



Photo 12: Brand and number of the tyre.

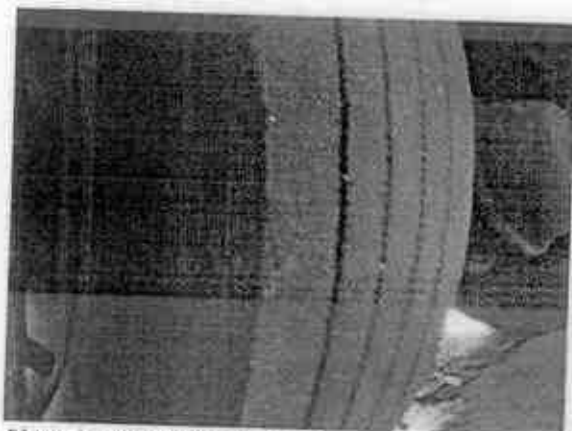


Photo 13: Unevenly worn tyre is seen.



Photo 14: Damaged rear mudguard and rear tyre rhs can be seen.

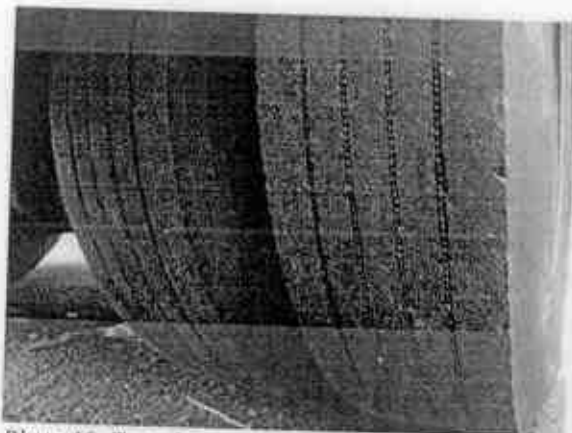


Photo 15: Tyre rhs rear can be seen.

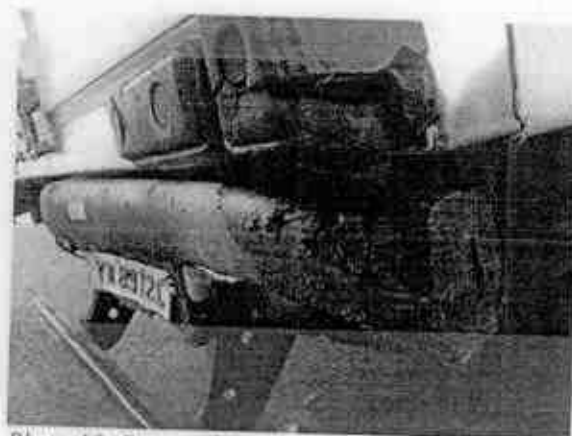


Photo 16: Rear cushion rhs worn and torn and rear number plate distorted.



Photo 17: Rear cushion lhs worn and torn.



Photo 18: Lhs rear mudguard distorted is seen.



Photo 19: Closer view of the torn and distorted lhs rear mudguard.



Photo 20: Rear tyre.

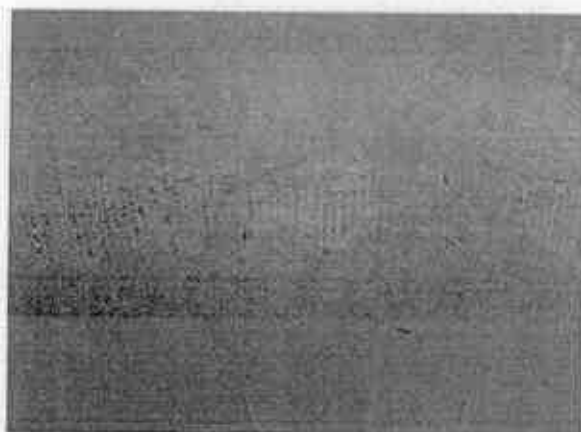


Photo 21: The side wall of lhs rear tyre can also be seen.



Photo 22: Tyre number.



Photo 23: Side wall of lhs rear tyre.

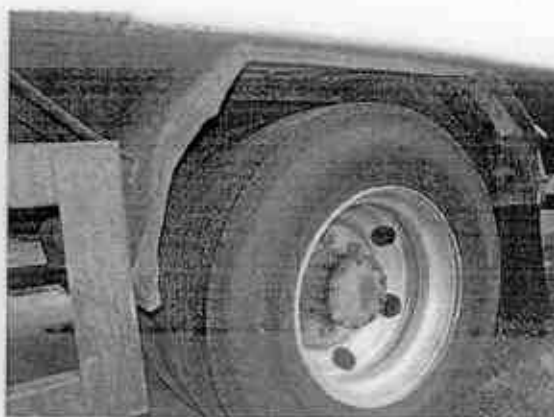


Photo 24: Another view of the distorted rear lhs mudguard.

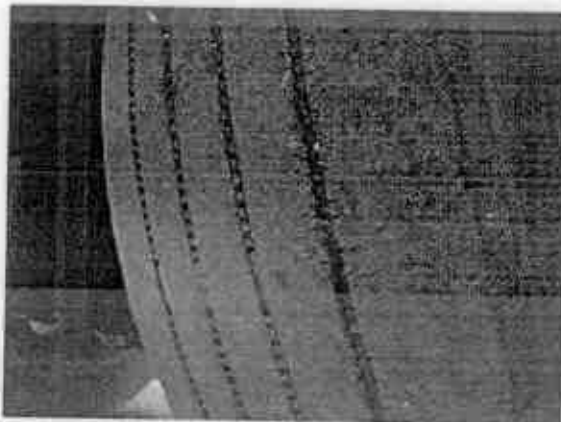


Photo 25: View of another tyre.



Photo 26: Instrument panel of the vehicle where air-pressure meter reading is seen to the right.



Photo 27: Vehicle chassis number.

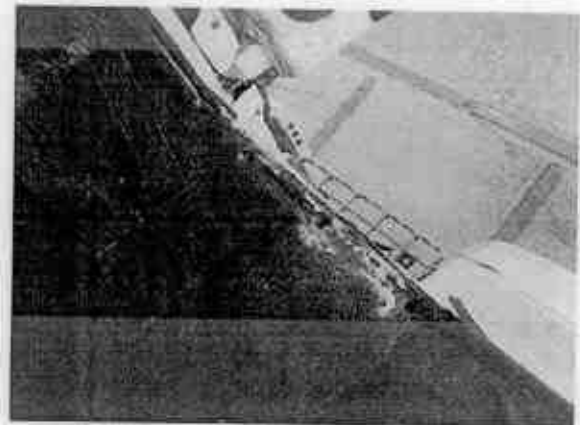


Photo 28: Corroded floor board on the driver side.

Check and evaluation of the vehicle maintenance records

- 3.9 ³Service History of the vehicle between periods 28 November 2011 and 5 November 2012 was made available by Alfred Lee Foo Lim, Service Marketing Supervisor of TCiM for examination.
- 3.10 During this time interval of 11 months 1 week, the vehicle had undergone some 35 Job Nos. out of which 12 Nos. or 34% had activities involving brake repairs and/or maintenance, e.g. overhaul rear brakes, overhaul front brakes, conduct brake test, adjust brakes, and brake not effective.
- 3.11 ⁴Job No. J1092348 show that a brake test was conducted to the vehicle on 5 November 2012.

However, there was no record of any work detail or result of the test.

³ Appendix 5

⁴ Appendix 4



Brake test facility

- 3.12 According to TCiM's Workshop Supervisor, Tan Kim Tow, brake tests were conducted on the road by mechanics without any instrumentation.
- 3.13 In other words, the effectiveness of the brakes was not measured and no readings printed or recorded to show its actual efficiency, but instead they were only judged by the individual mechanic's feeling and experience.
- 3.14 The recommended standard or methodology to gauge and measure a vehicle's brake efficiency is to test it on a roller-brake tester, similar to those used in the Vehicle Inspection Test Centres, accepted by the LTA.
- 3.15 This manner of brake testing eliminates human error or judgment that may vary from one individual to another.
- 3.16 Further, it provides tangible and objective results of the braking efficiency for both the front and the rear brakes.

Brake Static Inspection

- 3.17 The subject vehicle uses air-brakes.
- 3.18 Checks and tests carried out showed that the air build-up was slow.
- 3.19 It was also found that its air-pressure dip was more rapid than normal, suggesting either some leakage or a related deficiency in the system.
See Photos 29 to 30.
- 3.20 However, no further tests were carried out in this regard because of lack of test facility and tools.
- 3.21 Inspection of the front and rear brake air-chambers, push-rods and brake lever adjusters showed that they were cluttered with thick mud and dirt.
- 3.22 This would likely suggest that little or no attention had been given to this area for a lengthy period of time.
See Photos 31 to 38 and 41 to 42.
- 3.23 The Workshop Supervisor explained that the brake adjustments were carried out according to the recommended procedure as set out in the manual - first tightening the push-rod lever and then releasing it by three clicks. See Photos 41 to 42.
- 3.24 Unless the wheels are jacked up or suspended to check for binding, one cannot tell the integrity of the adjustment. See Photos 39 to 40.
- 3.25 Alternatively, measurement of the push-rod stroke helps ensure the proper level of the adjustment.



Photo 29: Air-pressure build-up for the braking system.



Photo 30: Air-pressure down to danger warning with 3 step applications.



Photo 31: Front air chamber (push-rod) appears muddy and dirty.

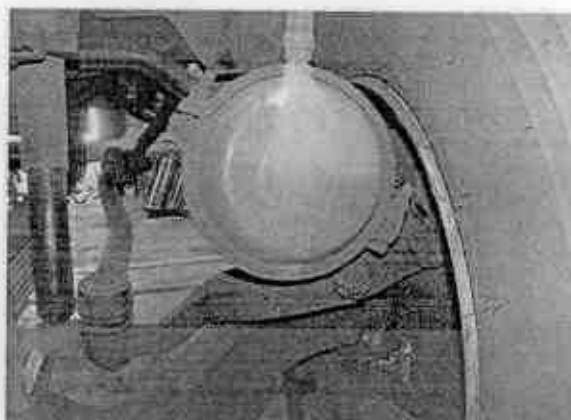


Photo 32: Other side of front air chamber and undercarriage with thick grease.



Photo 33: Air chamber push-rod and adjuster covered with thick dirt.



Photo 34: Another view of the front undercarriage.

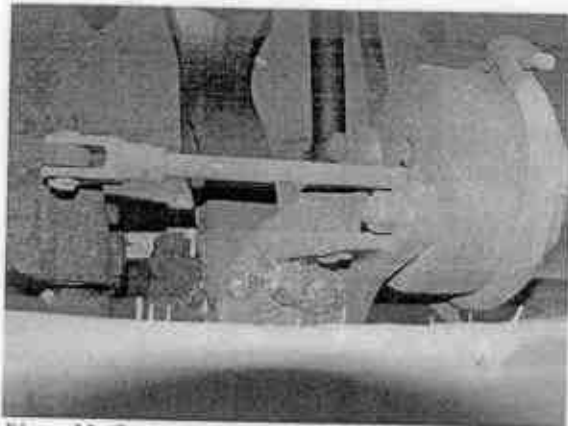


Photo 35: Front air-chamber push rod.

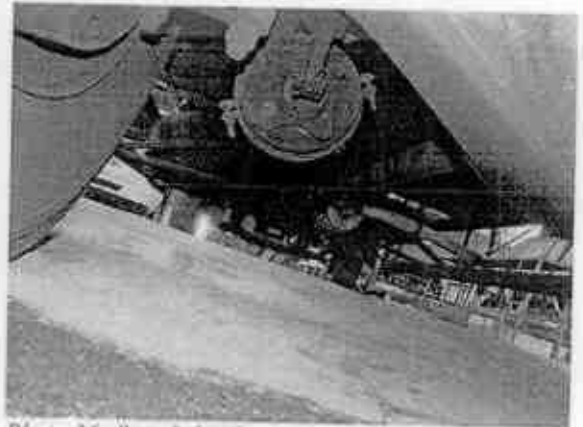


Photo 36: Rear left side of the air chamber.

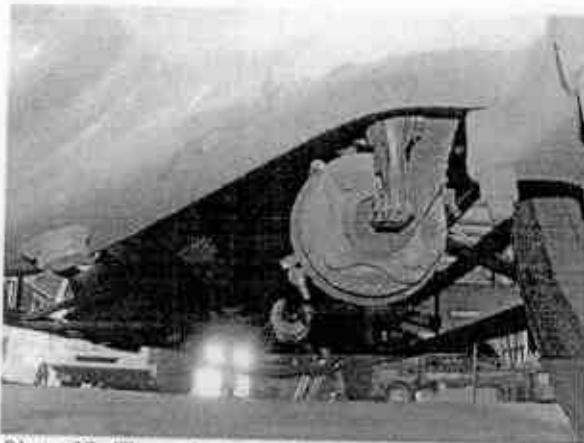


Photo 37: The right side of the air chamber push rod lever.



Photo 38: Another view of the right side air chamber.

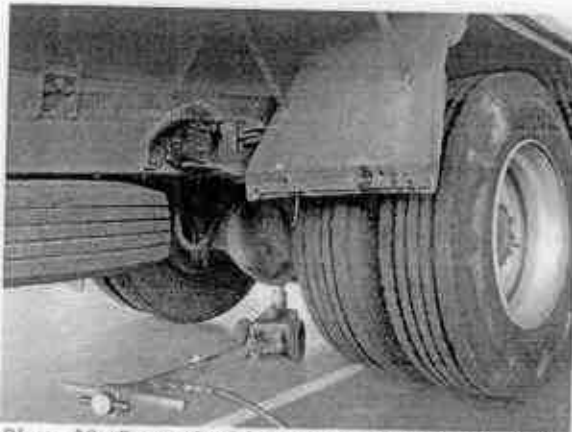


Photo 39: Rear wheel being jacked up for the brake test.



Photo 40: Another view of the brake test.

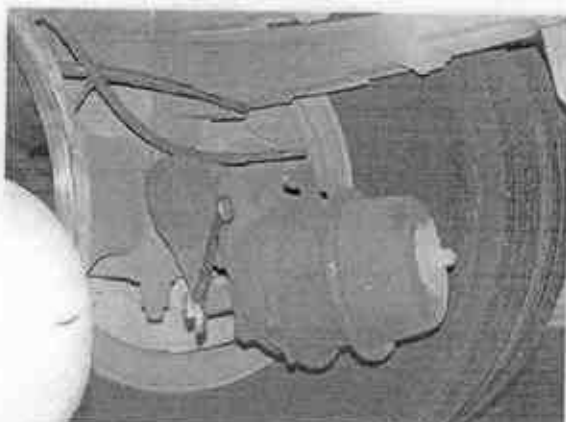


Photo 41: The rear brake adjustment shown by a mechanic.



Photo 42: Closer view of the brake adjustment.

STA Vehicle Inspection Centre

3.26 The vehicle was then driven by the Workshop Supervisor to the Jurong STA Vehicle Inspection Centre and the brakes were officially and independently tested.

3.27 The overall result was: "FAILED".

See details in Appendix 6.

3.28 Front brakes: 53%; Rear brakes: 19%; Hand brakes 12%.

3.29 Note that on the way to the Jurong STA, the brakes were tested on the road by the Workshop Supervisor, and Mr. Tan declared that the brakes were effective.

3.30 This would suggest that there was every possibility that a driver could be driving a vehicle with brakes deemed effective by the workshop mechanics even if they were actually ineffective as tested by the independent Vehicle Inspection Centre, STA, in this instance.

Further Brake Inspection

3.31 When the vehicle was brought back to TCiM's workshop again after the test at STA, I instructed that the rear brake drums be dismantled for inspection.

3.32 The inspection of both the rear brake drums with failed brake efficiency of 19% tested at the STA, found that there were evidence of overheating – the drums exhibit multiple crack, a phenomenon caused by overheating, normally attributed by incorrect brakes adjustment. See Photos 46 to 47, and 53 to 58.

3.33 The brake linings also appear to exhibit signs of fading attributed by overheating. See Photos 48 to 50.

3.34 Brake fade would cause loss or inefficient braking.

3.35 The rear brake drums were also worn.

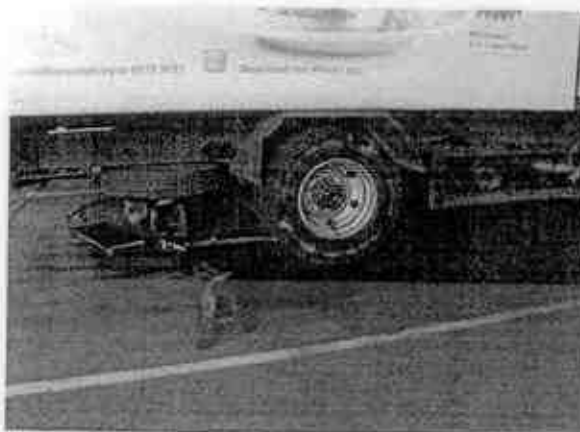


Photo 43: Rear right wheels jacked up for dismantling of the brake drums for inspection.



Photo 44: Mechanic dismantling the rear wheel.

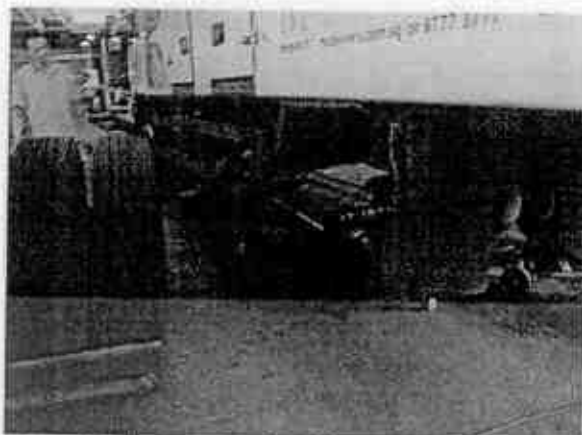


Photo 45: The left rear wheel being dismantled ready for inspection.



Photo 46: View showing cracks to the rear brake drum - evidence of overheating.

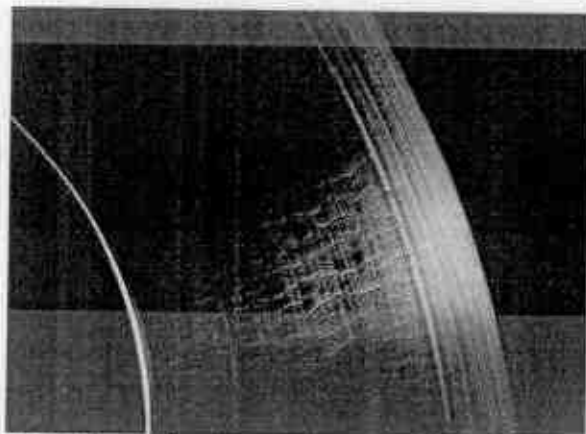


Photo 47: Another view of the cracked brake drum is seen.



Photo 48: The rear brake lining is worn out unevenly.



Photo 49: Uneven wear of the rear brake lining.



Photo 50: Brake linings appear faded due to overheating and need replacement.



Photo 51: The right wheel drum dismantled for inspection.

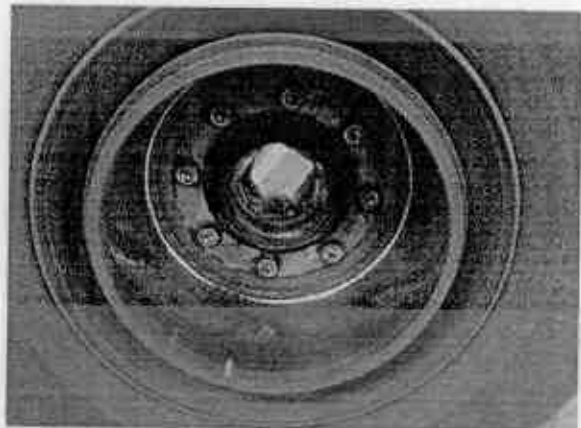


Photo 52: Closer view of the rear right brake drum.



Photo 53: Right rear brake drum show cracks, evidence of overheating brakes.



Photo 54: Another view of the brake drum cracks.



Photo 55: Close-up view of the cracks can be seen.

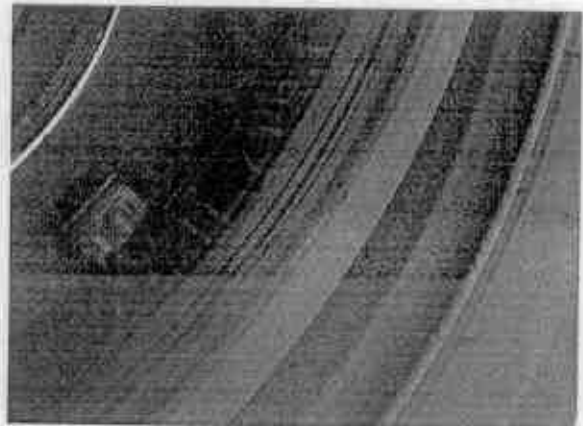


Photo 56: There is also evidence of excessive wear to the brake drum.

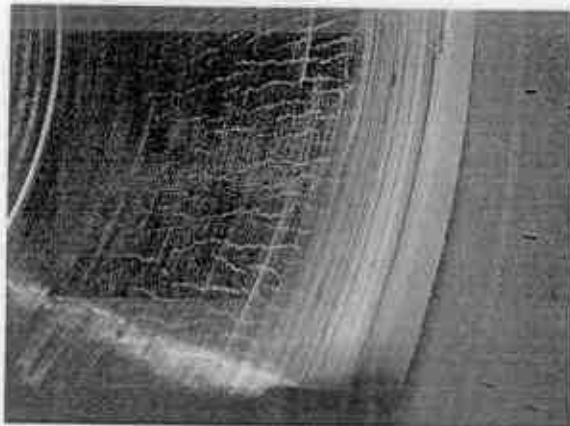


Photo 57: Cracks and excessive wear evident on the rear brake drum.



Photo 58: Another view of the right rear brake drum.

Interview with driver

- 3.36 An interview was conducted with the involved driver, Mr. Sun Xin Jian on 29 November 2012 at about 12 noon, in the presence of his Transport Duty Supervisor, Mr. Alvin Ong, his Assistance Transport Manager, Mr. Tong Kheng Chin, and MSIG Senior Executives, Ms Eng Huey Ni and Ms Foo Ai Ngoh.
- 3.37 Mr. Sun had some 9 years of heavy vehicle driving experience.
- 3.38 He joined Havi Logistics in 2008 and was familiar with the vehicle.
- 3.39 Mr. Sun carried out the necessary operating checks to the vehicle before he took off for the day's assignment at about 6 pm, and leaving for Bukit Panjang, PIE from the company's premises in Pandan Loop.
- II 3.40 He stated that he used a lot of his brakes on the way because of heavy traffic.
- 3.41 Mr. Sun said that his travel speed was about 50 km/h when he saw the amber light and applied his brakes. However, the brakes of his vehicle were ineffective, and he could not stop in time to prevent colliding into the 3 pedestrians.



Technical analysis

- 3.42 The fact that Mr. Sun applied brakes frequently under heavy traffic condition would have likely caused overheating of the brakes. Such overheating would be aggravated if the brakes were out of adjustment.

There is evidence of overheating of the brake drums found in our inspection.

Principle of Brakes

- 3.43 Braking converts kinetic energy (motion) into heat energy through friction between a brake lining and brake drum surface (friction surface).

The amount of heat produced by a brake system is directly related to the mass (weight) of a vehicle and the driver's desired velocity (speed) reduction.

Kinetic energy equals one half mass times velocity squared the amount of energy that the brake must convert to heat is doubled by doubling a vehicle's weight and quadrupled by doubling its speed.

Brake imbalance caused by poor maintenance, or light brake applications may cause an uneven distribution of brake heat with possibly overheating.

Typical generic "normal driving" temperature range for well-balanced vehicle brakes is 100 to 200 degrees. Constant braking under heavy traffic condition with improperly adjusted or binding brakes can produce brake temperatures between 200 and 400 degrees. A brake resin odour is produced at about ⁵550 degrees and visible smoke is produced at 850 degrees.

- 3.44 Brake Fade: When a failure of a brake system does occur, it is most commonly associated with some type of brake fade. Brake fade can be friction fade, mechanical fade, and others not related to the subject case.

Friction fade occurs when friction at the friction surface is reduced to an unacceptable level where the ability to convert kinetic energy into heat will also be reduced.

When friction fade occurs, the driver may report the pedal going to the floor.

Mechanical fade is commonly associated with drum brakes. As the brake drum heats up, it expands outward. This expansion will increase the drum's diameter, moving it away from the lining application.

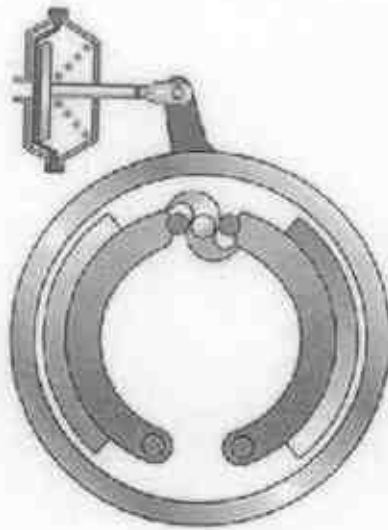
The expansion of the brake drum causes a need for increased lining travel and increased travel of the application device. If expansion is great enough, it can cause the application device to bottom out and the brakes to fail.

A typical S-cam brake chamber application normally has a maximum pushrod stroke capability of about 2.5 inches. Cold pushrod stroke measurements with Automatic Brake Adjusters (ABA's) are commonly found to be around 1.75 inches. Hence, a typical brake chamber will have a reserve stroke of around 0.75 inches.

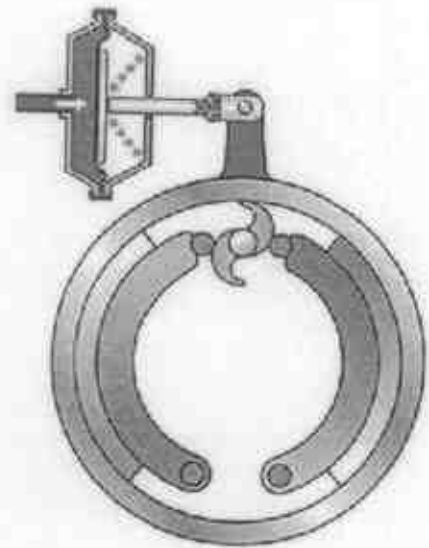
See ⁶diagrams as follows:

⁵ Carlisle reports (Crash Forensics, John C. Glennon)

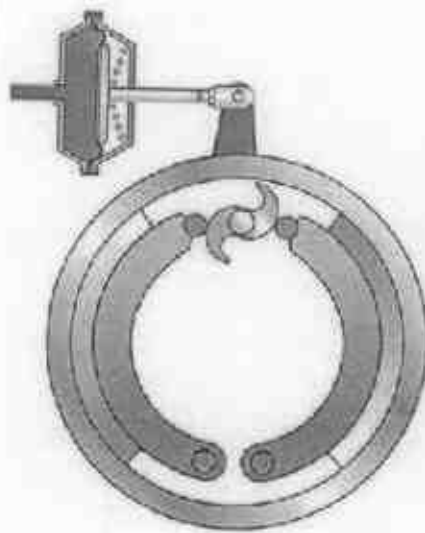
⁶ Air Brake Manual



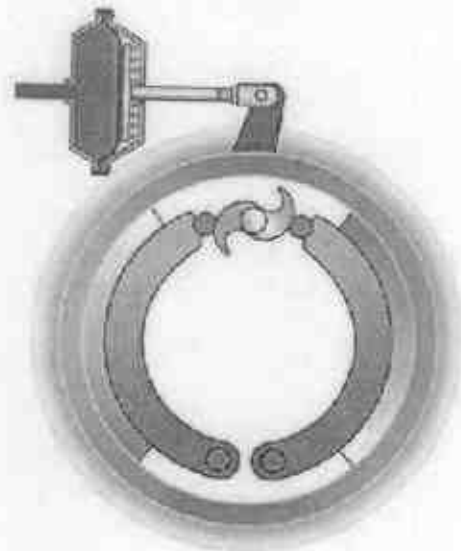
Typical S-Cam brake released



Typical S-Cam brake in applied position



*S-Cam brake incorrectly adjusted & cold
brake drum*



*S-Cam brake incorrectly adjusted & hot
brake drum*

As a brake drum expands away from the brake linings, the cold pushrod stroke will increase. A brake drum temperature of 400 degrees can increase pushrod stroke by as much as 0.5 inches. The force output of a brake chamber is not linear, and a typical brake chamber reaches its knee point where force will begin to drop at about 1.75 inches.

If the brake drum becomes hot enough, the brake chamber can bottom out and the brake chamber force output at that point will be 0.



4. Conclusions:

- 4.1 Based on the inspection and tests of the insured vehicle YM8972C, it is our opinion that its brakes were ineffective at the material time of the accident.
- 4.2 A brake test conducted at the Jurong STA vehicle Inspection Centre found its brakes "failed".
- 4.3 Inspection of the rear brake drums found evidence of cracks. *Normal?*
- 4.4 This was caused by overheating which caused brake fade and brake inefficiency attributed by improperly maintained and/or adjusted brakes.
- 4.5 The cracked brake drums and faded brake linings of the vehicle should be replaced; brake tests be conducted on brake roller testers; and brake efficiency readings for the vehicle be at least 50% for both the front and rear brakes.

I certify that the expressed opinions and conclusions have been formulated within a reasonable degree of professional certainty. They are based upon all of the information known by me at the time this report was issued, as well as knowledge, skill, experience, training, and education.

Report prepared by:

.....
Kelvin Koay BScEngg(Hons) PEng MIES MIEAust CPEng CEng MIMechE FIRTE
Principal Forensic Consultant
Chartered Professional Engineer