AECS
AUTOMOTIVE EQUIPMENT & TRAINING

Update 1
You may remember in last month's article, we shared with you part of our report on brake testers.

Introduction
It was brought to our attention by NZ government officials in Nov 2020 that a plate tester manufacturer co-funded the making of a report in Oct 2020 to somehow make plate brake testers seem more accurate than roller brake testers. There is a thing called "Funding Bias", meaning that the study can potentially support the interests of the study's sponsor.

We've read the document in detail and found it to be overall a well written document, with well supported evidence. However, if you look in-depth the "funding bias" is evident.

Link to report: http://casr.adelaide.edu.au/casrpubfile/2533/CASR173.pdf

Predictably, since the publishing of the AECS' article last month, this biased report has been used widely by plate brake tester resellers in NZ to somehow 'prove' to workshop owners, that plate brake testers are the better way to go.
Please allow me to take you through the report and show how this report clearly shows the flaws that plate brake testers have.

Note: After much deliberation, we thought it best that we share the findings with you so you are informed. If you missed last month's AECS article on brake testers, see page 4.

Just make up your own mind to see if it is correct why plate brake testers are not allowed for CoF purposes just like they should not be allowed be for WoF testing. We have analysed the report in detail and share our findings below:

• A brake robot was used for brake testing. A human is not a robot.
A robot creates reasonable repetitive results, a human cannot create repetitive results (see the report page 9, 14, 31 and 32) let alone different human beings across different testing stations on different testers.
According to this report, a roller brake tester does not need a robot to produce repetitive results (page 24).

• A brake robot was used on a truck roller brake tester. Using the brake robot is the equivalent of slamming brakes, something which is going to give some inertia readings. Especially on inground truck brake roller testers, is the inertia of the (much larger and heavier) rollers, gearboxes and motors noticeable when slamming brakes.

On page 24 the writer states that on the above ground, mobile ROLLER brake tester; *"there was generally little difference in the reported peak deceleration rates regardless of whether the brakes were applied in a rapid, strong manner by the brake robot or in a gradually increasing manner by the test driver."*

This statement supports the findings in the AECS report. Roller brake testers produce repeatable (objective) brake test results

• Page 17&18. An NZTA approved roller brake tester will rotate the wheels at approx. 5km/h (cars) and approx. 2.5km/h for trucks. The tester used was rotating the wheels at 0.5km/h. This does not seem to be a tester we'll see here in NZ. The roller brake tester brand VIS as used does not appear in the NZTA VIRM list of approved equipment.

• Page 7 & 24. The statement that it is common for the vehicle to be ejected from the tester is in most cases incorrect. When the vehicle's rear wheels have grip on a level surface (NZTA requirement) and its brakes are working correctly the rear brakes will act perfectly as an 'anchor'.

Furthermore, the mobile brake tester used does not have a raised rear roller (see page 18) which most inground brake testers, built to ISO 21069 standards, have. The raised rear roller is to enable a front axle brake test to be completed when rear brakes or the proportioning valve are faulty. Further, it is an accepted procedure to either chock the wheels (that are not in the roller) on trucks and to apply the hand brake (on cars) when ejection is a problem. The locking of the vehicle on the ground by park brakes or chocks to assist the testing of the brakes of the axle in the roller is perfectly acceptable as it does not interfere with the brake force of the axle to be tested.

Throw away opinion comments like "Using the handbrake during a footbrake test is clearly not a valid procedure,..." shows clear funding bias and does not do the report any justice.

• When the brake pressure is limited the initial brake pressure (left vs right) is equal (study page 13 graph!), unlike actual faulty brakes. This means that before the vehicle is ejected the brake balance measured is naturally perfect.

• The plate brake tester results (page 40 figure 4.7, red squares) show's deceleration rates varying between from +/- 8.4m/s2 to +/- 7.8m/s2 (very similar) from good brakes to completely faulty brakes.

The roller brake tester (blue circles) shows results varying from +/-5.8m/s2 to +/-2.8m/s2 with the same faults induced in the brakes. Please note that <5m/s2 is a fail for NZ WoF.

• Brakes testing in NZ is for consistent peak deceleration rate, not average deceleration rate like it seems to be in Australia (page 4). Peak deceleration rate is a measure for the highest brake force measured in conjunction with the vehicle's weight measured at the same time.

It is assumed that to get plate brake tester brake efficiency results similar to roller brake tester brake efficiency results, the software in some plate brake testers will use the average brake force oscillations combined with the static weight, called the average deceleration rate. This is to overcome the fact that oscillation matching is highly inaccurate on plate brake testers.
By design, a plate brake tester cannot produce accurate and repeatable brake efficiency results, especially when human beings are pressing the brake pedal.

Evaluation of results:

• Pg.44 Brakes in peak condition. The roller brake results (despite the reported ejection) should be a pass, yet indicated as a fail, is there perhaps a mistake or bias in this report?

• Pg.48 One faulty front brake. The imbalance values are result of vehicle ejection, as a result of the rear wheels being on a steel ramp up to the rollers, before the brake pressure limiting of one wheel came into play. I detect careful manufactured bias in the used testing method.

• Pg.50+51 Faulty rear brakes. Correctly shows a fail only on the roller brake tester.

• Pg.53 One faulty rear brake. Shows correctly as a fail on the roller tester as the vehicle uses the front brakes as an 'anchor'.

Conclusion page 59

In the conclusion, the writer completely fails to address the fact that the high-speed distance test (objective test) has a direct relation to G force or brake efficiency, as nicely described in the NZTA VIRM: the 30km/h stopping distance in 7 meters rule. Brake efficiency is the key testable data. A plate brake tester can NOT produce reliable brake efficiency figures, a roller brake tester can.

The writer focuses on brake force in relation to induced brake pressure faults. In reality, brake imbalance caused as a result of pressure limiting on one wheel are in my view extremely rare.

To name a few, for example:
1) A seized calliper will have a great imbalance on low brake force and brake drag, and depending on its severity, no effect on high brake force. Something that cannot be measured with brake plates.

2) Brake shoe/pad lining worn away usually gives a percentile imbalance from low to high brake force.

3) A faulty proportioning valve will reduce or increase rear wheel brake force (front to rear balance). The increase of rear brake force (locking up rear wheels) cannot be measured on plate brake testers, as due to the vehicle's inertia the rear axle will 'lift off' the platform locking up the wheels regardless.

4) Oil on the brakes will give a percentile imbalance across the range of brake forces.

None of the actual faults mentioned above will have similar brake imbalance faults as result like the imbalance invoked by the pressure limiting.

Conclusion

In my opinion, I am not sure what the writer of the report has tried to prove with the induced faults other than trying to find 'proof' of a favourable outcome for the flawed design of plate brake testers over industry-standard roller brake testers.

BRAKE TESTING

ROLLERS | DECELEROMETERS | PLATES

By Herbert Leijen

In this article we will take you through Automotive brake test engineering from an equipment and automotive perspective. This article will have portions of an official report made recently. I hope you find it overall a pleasant read, yet be prepared to read through some of the (dry) theory and data if you have any interest in upskilling in testing of automotive brakes in general.

Bias Declaration

AECS sells and installs car and truck brake testers for WoF, CoF (A and B) and general pre check purposes. The staff at AECS are IQPs (NZTA Independent Qualified Persons), and are authorised to calibrate, commission and install brake testers of two brands in NZ. We are NZTA approved RBM trainers (for CoF vehicle inspectors). We see many different brands of roller brake machines; most are good equipment providing consistent and reliable results.

What do you need to test with a brake tester?

Stated in the NZTA Virm, chapter 8-1,

- *A service brake that acts on each wheel must stop the vehicle within a distance of 7m from a speed of 30km/h (average brake efficiency of 50%).*

sub-chapter 13:

- *A Parking brake must stop the vehicle within 18m from a speed of 30km/h (average brake efficiency of 20%).*

There are a number of extra testing criteria like; directional control vibration and progressive application, but in this article for simplicity I will focus mainly on brake efficiency.

Brake Efficiency

Facts:

- G is an abbreviation of gravity.
- Gravity in NZ is approximately an acceleration (deceleration) rate of 9.8m/s2.
- Decelerating from 30km/h over a distance of 7 meters creates 0.5G.
- Brake efficiency is a direct cross over to deceleration rate;
  a brake efficiency of 50% is equal to 0.5G,
  60% brake efficiency is equal to 0.6G, etc,
- Brake efficiency is the relation between weight and brake force measured at the same time!
  Weight (kg x G) in Newton divided by brake force in Newton equals brake efficiency.
- A brake efficiency of 100% is not possible unless the vehicle is running on gears.

The grip coefficient between warm soft rubber (tyres) and high grip new Corundum surface almost never exceeds 0.9f, which means a brake efficiency of more than 90% is possible but becomes unrealistic. 90% brake efficiency equals 0.9G. An F1 car can brake with much higher G forces due to down force (un-real weight) on the car as a result of aerodynamics.

Different testing methods
There are three types of brake test methods: decelerometer, plate brake tester and roller brake tester.

- Decelerometer.
This very low cost tester is a single axis G force meter. It simply tests the deceleration rate of the car (including the tilt of the car). There is no way that individual axle brake performance (axle efficiency), directional stability (difference), ovality (warped discs) or brake drag (seized callipers) can be measured with a standard decelerometer. This is why for commercial vehicles the decelerometer is only allowed by exception. A decelerometer is a reasonably good tool to measure deceleration.

- Plate brake testers
Plate brake testers stem from the earliest era of brake testing where a platform moved in against a spring, pushing oil with a hydraulic ram into a tube. The height of the oil pushed up into a glass tube on a board was the indication of the brake force exerted on the plate.
In the late nineties I was trained by the designers, on the technical background, calibration, and installation on the electronic equivalent of plate brake test machines.

In the EU at that time the plate brake testers were only allowed to be installed in Norway to cope with steel spiked tyres. Their use worldwide, is even today extremely limited.

Effectively the hydraulic ram in the plate brake tester has been replaced by an electronic force sensor, the glass tube on the board is replaced by a computer screen showing bar graphs moving up by brake force. The red oil sticking in the glass tubes (to indicate max brake force) was replaced by a 'maximum force' function in the software, displayed on a screen.

Plate brake tester (fitted incorrectly) above ground

The fact that my personal first experience with the plate brake testers produced inconsistent results, made me criticise the actual designers, who were training me back in the late nineties. The most interesting remark from the designer/trainer was, that as a matter of design a plate brake tester's results are subjective.

In layman's terms this means that the operator can get pretty much get whatever result they want out of a plate brake tester, unlike a roller brake tester or decelerometer. In the practical reality it is virtually impossible to get consistent results even if the tester could calculate efficiency with the dynamic weight and brake force. It is the human element in the brake plate tests and the design of this type of tester that creates the largest inconsistencies in brake results.

The brake plate tester in reality can only provide reasonable consistent results when a car with locked up brakes, is pulled across the brake test plates in a gentle manner (wheel skid). The rope used for pulling the vehicle across the plates needs to be perfectly horizontal to make sure no weight is added or is removed from any axle. This test still does not test the full circumference of the brake (ovality).

The fact that brake plates are still around is because they are incredibly cheap to produce compared to brake rollers. The actual brake force sensor is really the only 'expensive' part that both types of testers share.

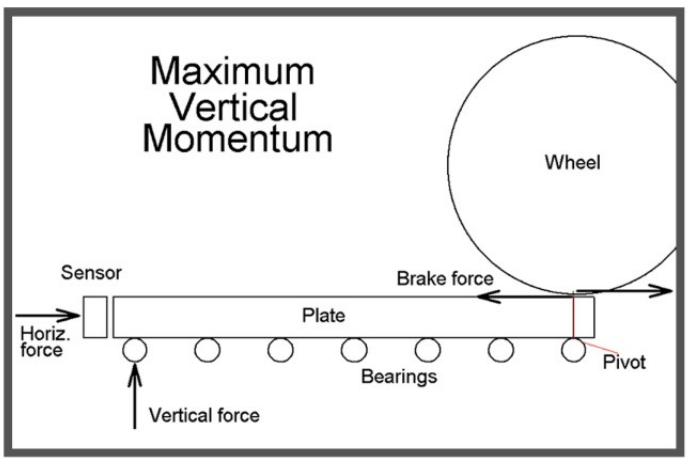
In a plate brake tester is a lot less steel, there are no bearings, chains, motors, gear boxes, speed sensors, or rollers compared to a roller brake tester. They are also very cheap to install if they are (incorrectly) fitted above ground.

Plate brake testers can produce incredibly variable results on the very same vehicle back to back by slightly varying how the test is performed as our research shows.

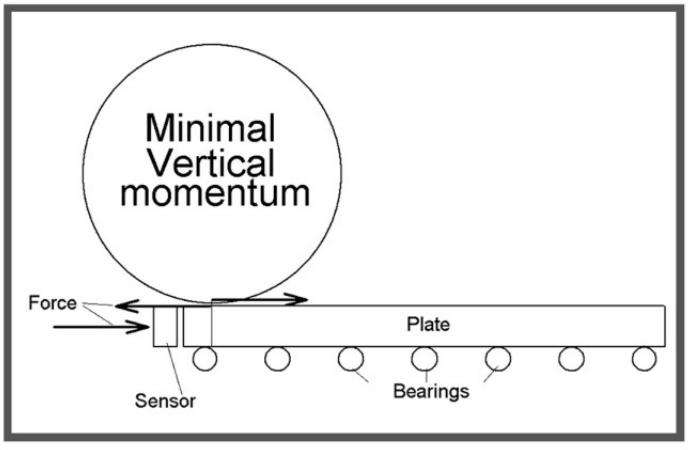
A plate brake tester should use dynamic weight during a brake test in which you will have to lock the wheels to calculate properly axle efficiency.

The difficulties are:

- The shift in weight (inertia of the vehicle) when braking, increases the brake force on the front axle and decreases the maximum brake force on the rear when lock-up occurs.
- Some of the brake force will be transformed into weight reading due to the momentum on the brake plate.
- When driving onto the brake plates when they are above ground (not flush), causes weight oscillations.
- Lock up on the plates gives weight oscillations and brake force oscillations.



< Wheel locking up on the entry of the plate. The brake force on the plate is partially transformed into vertical force, due to the momentum on the bearing at the entry of the plate. The total brake force measured is less than what the brake force actually is.



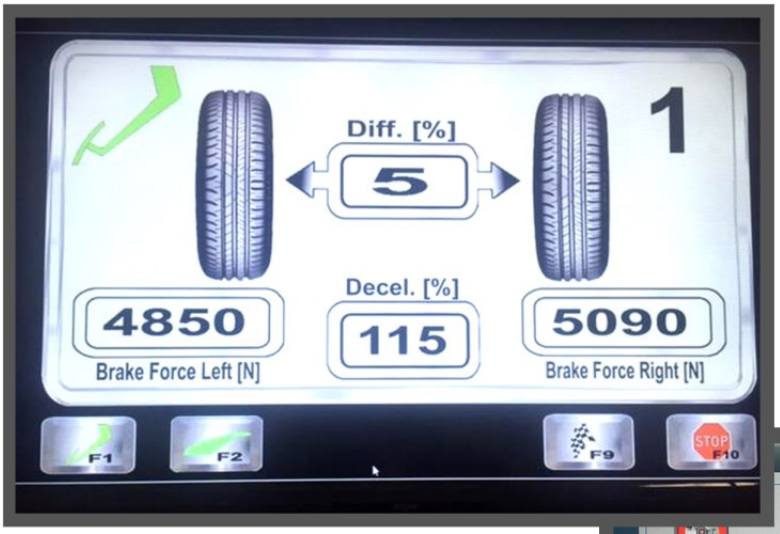
< Wheel locking up on the exit of the plate. All brake force is measured by the brake force sensor.

On brake plates the brake force oscillations and weight oscillations need to be matched carefully and rebound must be removed from the results before efficiency can be reasonably calculated.

It is for this reason that way back in the late nineties the engineer's setup the software so that the vehicle's static weight was used in efficiency calculations. What we have found during our research about 23 years later that on equipment available in NZ, that the static weight is still being used!

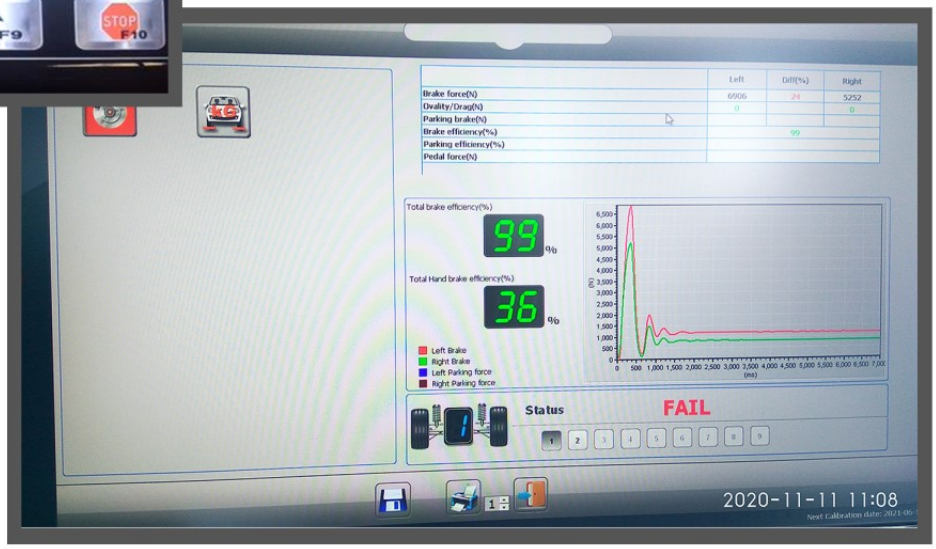
That is immediately visible by anyone using a plate brake tester when brake efficiencies are getting unrealistically high without even locking up the wheels.

We have seen testers producing results of more than 100% brake efficiency without any 'aerodynamic downforce' in the workshops!



< Picture from the factory User Manual of a plate brake tester. Please note the 115% deceleration rate (efficiency) of that axle in the centre display.

Picture from a different type of plate brake tester. The 99% efficiency is actually higher when the values in the screen are used. The software has actually limited the results to 99%, which gives it some sort of correct 'feeling'. >

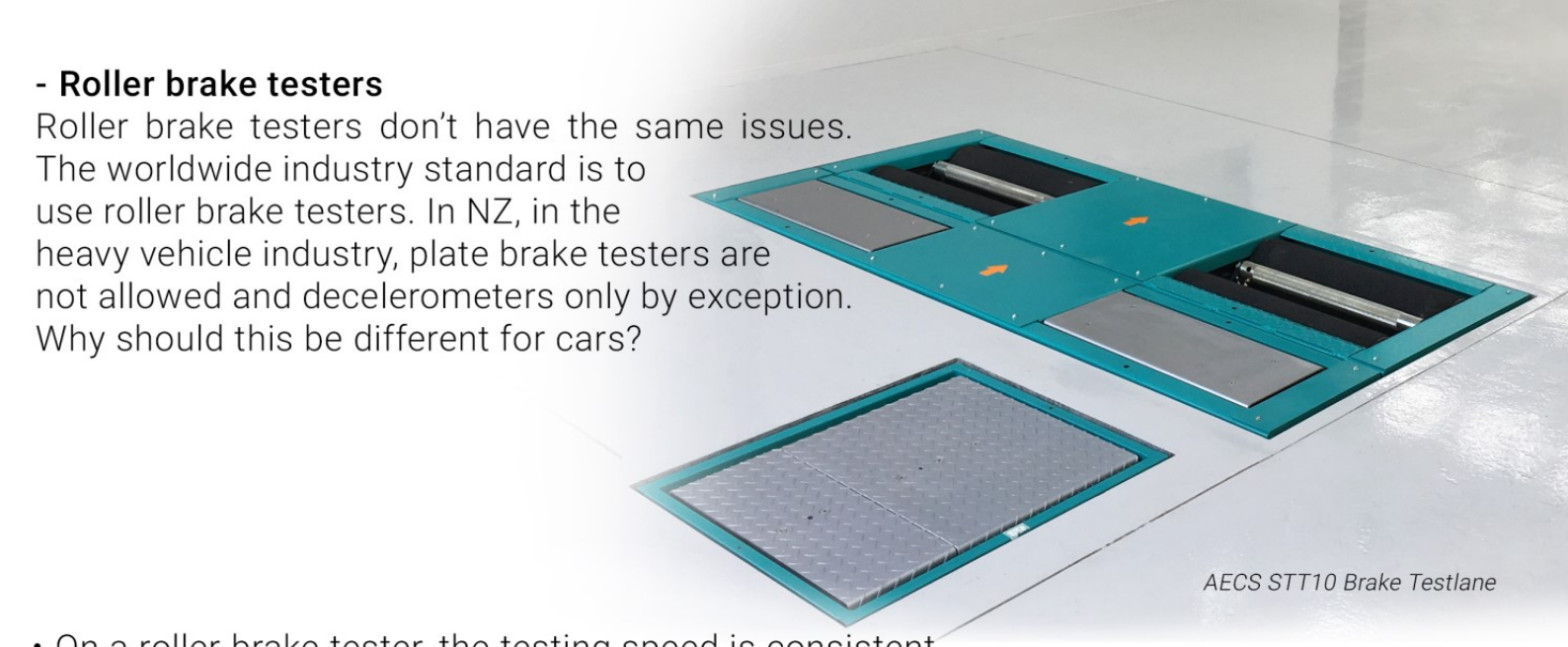


On the plate brake tester to get accurate test results and comparison between the front and rear axle you need to test both axles at the same time, at the same spot of the plates. To do this for example on the front axle first and the rear axle later, produces meaningless results as the speed and deceleration rate of the vehicle will be different (subjective results).

In short you can pretty much pass any vehicle or fail any vehicle with a plate brake tester. Please look at the huge variations of test results later in this article.

- Roller brake testers

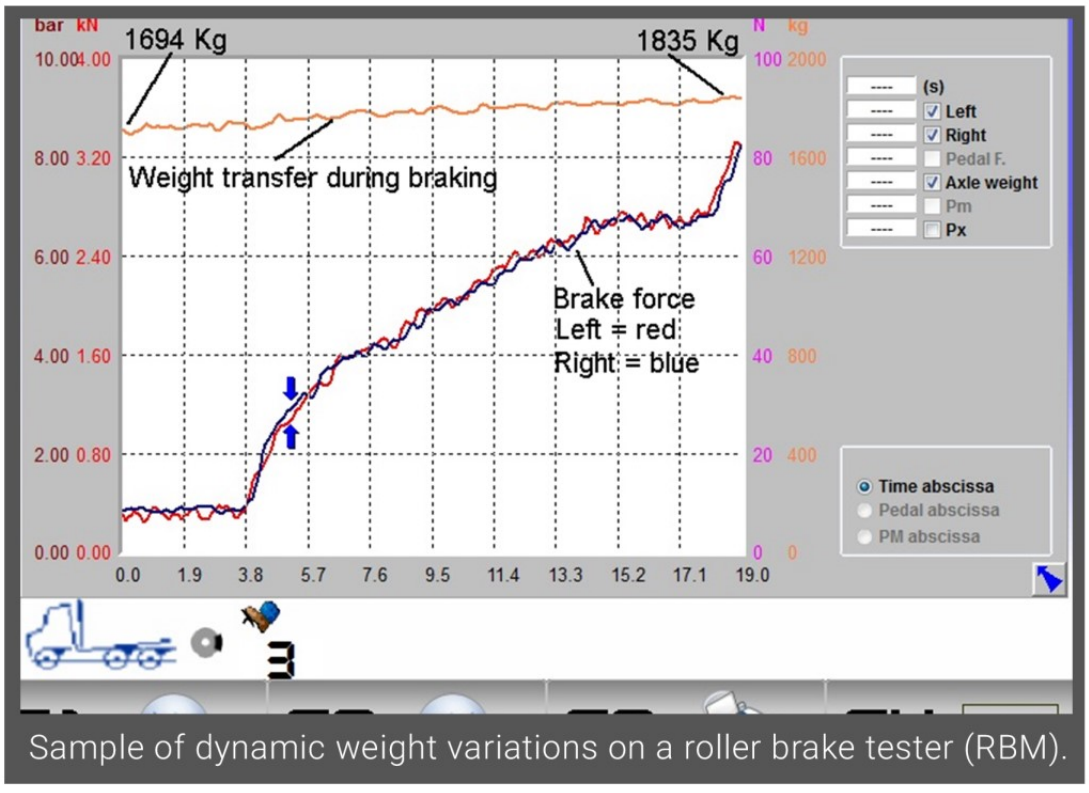
Roller brake testers don't have the same issues. The worldwide industry standard is to use roller brake testers. In NZ, in the heavy vehicle industry, plate brake testers are not allowed and decelerometers only by exception. Why should this be different for cars?



AECS STT10 Brake Testlane

- On a roller brake tester, the testing speed is consistent.
- On a roller brake tester, the weight of the axle (wheels) is almost consistent (plus dynamic weight recording can be and are being used).
- On a roller brake tester, pedal force is not measured in NZ as the brake test will terminate when one or both wheels lose traction (brake until wheel lock occurs).
- The vehicle is longitudinally always placed in the centre of the tester, not affecting weight readings, plus the resultant force on the frame will not affect the brake force readings.
- On a roller brake tester, the skid of the tyre on the roller is measured (slip percentage), something which is not possible on brake plates.
- On a roller brake tester, and with the brakes (and proportioning valves) in good working order it should almost always be possible to lock the brakes.
- On a roller brake tester, the quality of the suspension is not a factor in brake force and brake efficiency calculations.

Roller brake testers fitted with weight sensors (and equipped with the ability to calculate efficiency) produce repeatable and representative brake efficiency results, where plate brake testers do not. Simple really.



Sample of dynamic weight variations on a roller brake tester (RBM).

Test results with the same vehicle.
Below are some practical tests we have done with our 2018 Hyundai service van (33,000km) on a newly installed plate brake tester.

Actual vehicle weight with no driver in the vehicle, no freight and half a tank of fuel.
LHF **698kg** RHF **692kg (axle weight 1390)**
LHR **528kg** RHR 510kg **(axle weight 1038)**
These weights are verified with newly calibrated traffic police weight scales.
True Total Weight = 2428kg

Practical tests
Following is a series of results of which we can produce photos and video.
Realise that the tests have been done with the same vehicle within minutes from each other.

Since the weight was not calibrated correctly on this particular tester, we used for the actual efficiency calculations the confirmed static (empty) weight of the vehicle. If you add the driver to the weight used the 'actual efficiency' lowers by about 4% on an axle weight of +/-1000kg, making the discrepancy between actual and displayed efficiency worse.

Test 1: Plate brake results Normal drive on, with gradual braking.

	Axle Brake Force measured	Actual Axle weight empty	Displayed Axle weight	Actual Efficiency	Displayed Efficiency
Front Axl	5,507N	13,622N	10,966N	40.4%	50.2%
Rear Axl	539N	10,172N	7,859N	5.2%	6.8%
Total Vehicle	6,046N	23,794N	18825N	25.4%	32%

The tester shows a total vehicle efficiency of 32%, calculated with the actual axle weight this is 25.4%, that is in all rule books a WoF fail on this late model vehicle!

Test 2: Plate brake results Normal drive on, harder braking.

	Axle Brake Force measured	Actual Axle weight empty	Displayed Axle weight	Actual Efficiency	Displayed Efficiency
Front Axl	7,070N	13,622N	10,887N	51.9%	64.9%
Rear Axl	3,421N	10,172N	7,849N	33.6%	43.6%
Total Vehicle	10,491N	23,794N	18736N	44%	55.9%

The tester shows a total vehicle efficiency of 56% (a WoF pass), calculated with the actual axle weight the efficiency is 44%, that is still a WoF fail.

Test 3: Plate brake results Faster drive on, with gradual braking.

	Axle Brake Force measured	Actual Axle weight empty	Displayed Axle weight	Actual Efficiency	Displayed Efficiency
Front Axl	7,316N	13,622N	10,976N	53.7%	66.6%
Rear Axl	2,430N	10,172N	7,898N	23.9%	30.7%
Total Vehicle	9,746N	23,794N	18874N	41%	51.6%

The tester shows a total vehicle efficiency of 52% (a WoF pass), calculated with the actual axle weight the efficiency is 41%, that is still a WoF fail.

Test 4: Plate brake results Faster drive on, harder braking.

	Axle Brake Force measured	Actual Axle weight empty	Displayed Axle weight	Actual Efficiency	Displayed Efficiency
Front Axl	12,158N	13,622N	10,848N	89.2%	112%
Rear Axl	6,815N	10,172N	7,869N	67%	86.6%
Total Vehicle	18,973N	23,794N	18,717N	79.7%	101.3%

The tester shows a total vehicle efficiency of 99%. This is not possible! And it is rounded down from 101.3%, calculated with the actual axle weight has the efficiency of 79.7%.

Please realise that all brake tests are done with the same vehicle with the same trained operator within minutes of each other without locking up the brakes.

Picture of one of the plate brake tests.

Vehicle Test Results

Date 3/02/2021 07:14:21 Reference No. 10002297

Device Type	STT45	Manufacturing No.	201801237
Homologation No.	NZTA	Manufacturing date	2019-01
Software version	2.0.1	Next calibration date	2020-05-18
Vehicle Type	Truck (MD3,MD4,ME,NB,NC)	Register plate	LJQ299

Brake results
End time 07:14:21
Axle test mode Automatic

Inspection Options	Unit	Limit	Front axle	Rear axle
Wheel weight left	kg		773	512
Wheel weight right	kg		756	513
Axle weight	kg		1529	1025
Service brake				
Brake force left	N		4576	3193
Brake force right	N		4364	3227
Axle efficiency	%		60	64
Difference	%	<=30	5	15
Rolling resistance left	N		220	155
Rolling resistance right	N		240	115
Ovality left	%	<=50	10	22
Ovality right	%	<=50	15	19

Parking brake	Unit	Limit	Rear axle
Brake force left	N		3466
Brake force right	N		3588
Axle efficiency	%		70
Difference	%	<=50	3

Summary results	Unit	Limit	Value
Total measured weight	kg		2554
Service brake total brake force	N		15360
Service brake efficiency (measured weight)	%	>=50	61
Parking brake efficiency (measured weight)	%	>=20	28
Brake Result			Pass

AECS STT45 BRAKE TEST REPORT

Roller test results

Below are the brake test results of the exact same vehicle on a recently installed STT45 truck roller brake tester (in truck mode). The weights are with a driver and some tools in the vehicle.

Please note on truck brakes the difference should be not greater than 30% (<=30) over 4KN.

If we break down the results, we get the following:

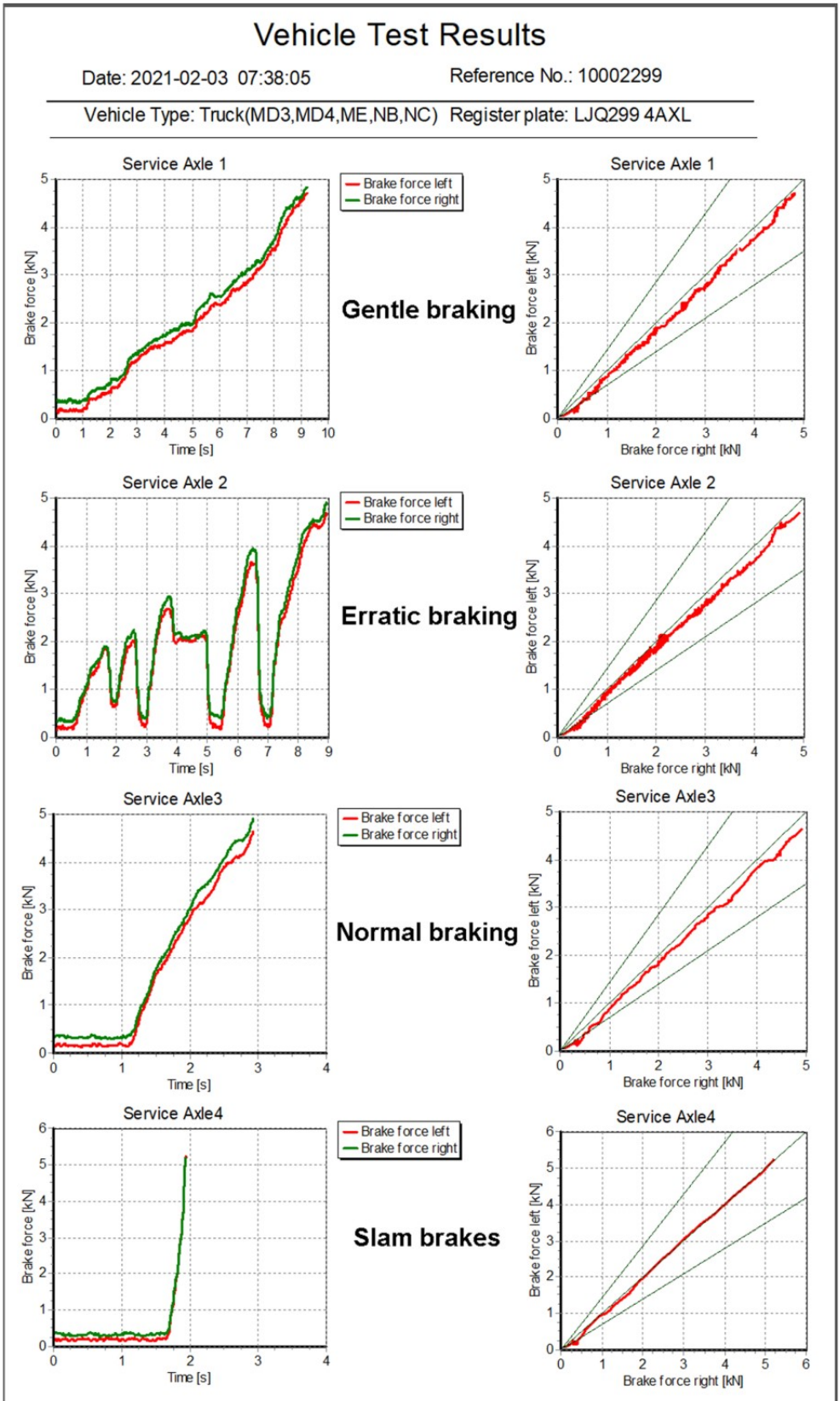
	Axle Brake Force measured	Actual Axle weight empty	Dynamic Axle weight	Actual Efficiency	Displayed Efficiency
Front Axl	8,940N	13,622N	14,984N	59.7%	60%
Rear Axl	6,420N	10,172N	10,045N	63.9%	64%
Total Vehicle	15,360N	23,794N	25,029N	61.4%	61%

Testing of this vehicle can be repeated over and over by any operator with always similar results, with very few exceptions (e.g. slamming brakes).

To prove the consistency of a modern roller brake tester we have tested the same front axle 4 times in one test. Below are test results of very different brake applications, from gentle braking to slamming the brakes.

Please note the time base and the lock-up brake force in each graph.

In the graph (left) you can see that only when you slam the brakes on a slight increase of lock up brake force is measured as a result of the brake rollers and motor inertia.



Screen dump of 4 times the same front brakes of the same vehicle.

There are many more tests and conclusions that were made, which are not covered in this article to keep the length of this technical article under control. Like for example grip coefficient of the plate surface and workshop floor, brake balance, difference, drag, ovality, centre of weight shift, and much more.

Conclusion

Are cheap brake testers really worth it? Please note that plate brake testers are actually not approved for CoF B in NZ. Should we as an industry look at ourselves and use the best practise for the good of our credibility, rather than wait for the law to regulate and forbid certain types of testers for WoF? AECS will not distribute testers we do not believe in, we keep it simple and clean, helps us sleep well at night!

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Ph 06 874 9077

NEWS
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New STT10e installation that was recently completed by our team.

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Read more here

JAMES FROM CLOUTMAN BROS MINING & DREDGING

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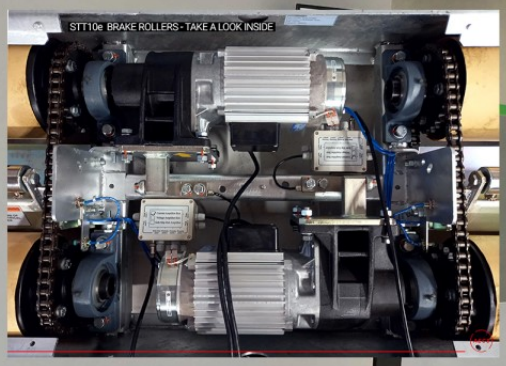
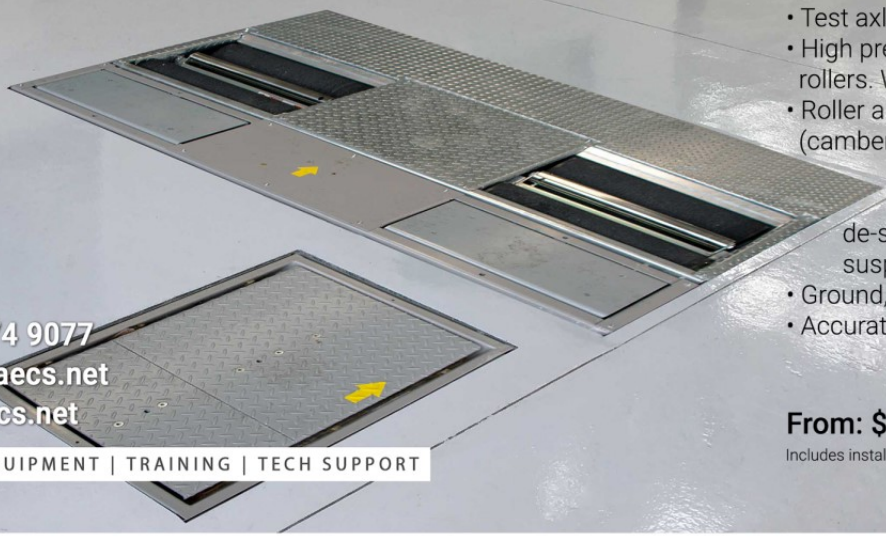
AUTOMOTIVE WORKSHOP EQUIPMENT



CAR TEST LANE
STT10e

STT10e car test lane uses the best and proven mechanical engineering solutions for your workshop. The STT10e is designed for various types of braking systems and for all types of motor vehicles.



Tech Specs

- 8KN per wheel brake force
- 4x4 testing
- 4T axle load
- 3KW straight drive ABM (German) motor and gearbox with auto brake.
- Test axle width 800mm - 2200mm
- High precision and high grip corundum rollers. Wet >0.6 Dry >0.85.
- Roller alignment to prevent drag and (camber) pull, influencing brake force readings
- Hot dipped galvanized frame
- Side slip tester with suspension de-stressing plate 25hz Eusama suspension tester
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- Accurate and repeatable results

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- Deep diagnostics mathematics to make things easy!

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