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Technical Newsletter

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Automotive Electronic Control Systems

AECS
Training, Equipment and Data for Automotive Diagnostic Specialists

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Brake, Suspension and Side slip testers,

The Facts...

A = Sideslip tester, B = Shock absorber tester, C = Brake tester

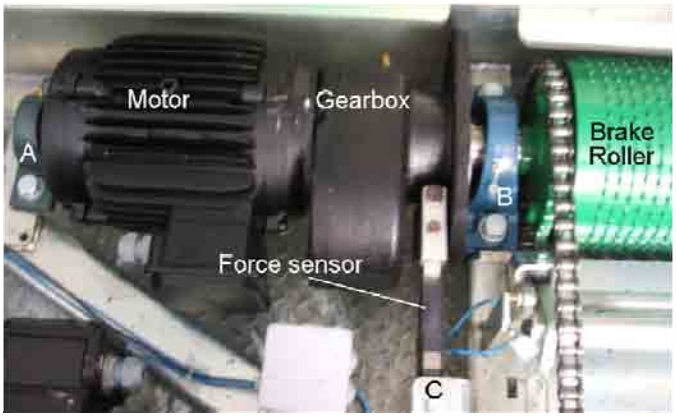
AECS Ltd is the NZ distributor of the VTEQ test equipment since 2001. AECS is also heavy engaged in high tech automotive training throughout the country.

In this series of technical articles I try to explain the functions of some parts of the VTEQ brake test lane from the technical perspective to show what you can do with such a machine. I will also try to wet your technical appetite about suspension and brakes.

A full test lane consists out of a Side slip tester, a Suspension tester, a brake tester, and even an emission tester, sound (Db) and beam setter can be integrated into the test lane
In the October 2009 article I explained in simple terms the suspension tester; following is a description of what can be done with the brake tester.

Brake tester:
The first platform the vehicle drives over without hesitation is the sideslip tester. The second platform in the test lane that the vehicle will drive onto with both wheels is the suspension tester (B). The third test that the vehicle's axle will drive onto is the brake tester (C), sometimes called rolling road.
The brake tester has one pair of 'grippy' rollers for each wheel of one axle.

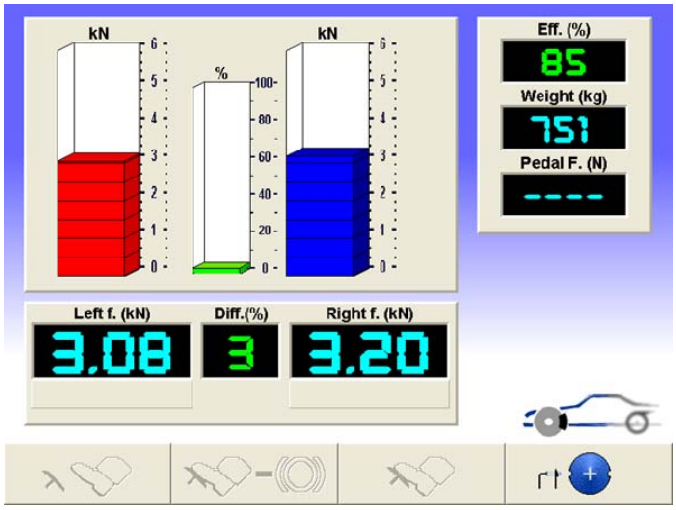
The rollers are driven by an electric motor, which is held in position by a force cell. The electric motor wants to rotate around its shaft (bearing A and B) when it needs to do an effort to rotate the rollers, for example when you have a car with applied brakes on the rollers. The force sensor which stops the motor from rotating around its own shaft, is nothing but a bar which 'bends' when torque is applied on it.



Picture of 5.5KW VTEQ 3080 brake tester motor and force sensor.

The amount of bend is measured by the tester's electronics and is transformed into a brake force value, which gets indicated on a PC screen or by needles in an analogue tester.

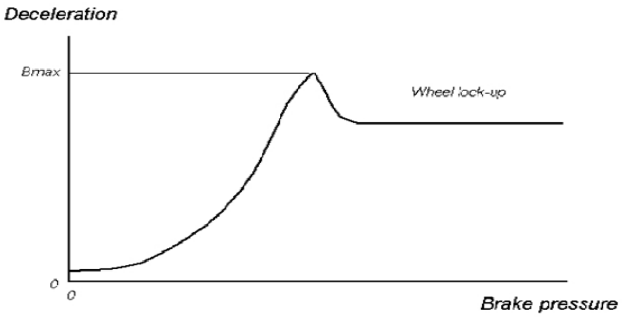
Budget 6KN analogue brake tester display



Display of top of the line digital 12KN brake tester.

Simply described, the brake tester records the force sensor's reaction while braking and compares it with the opposite wheel of the same axle.

A digital tester can do much more with the recorded data, but before options get considered a brake force graph needs to be understood.



AECS ABS traction control training seminar deceleration rate / brake pressure relation graph

In the graph on page 2 you can see that the deceleration rate increases when the brake pressure gets increased.
In the beginning the slope is somewhat hesitant as the brake pads are still cold and the grip between the pad and the brake disc is not ideal (brakes have an ideal temperature).
Later in the graph the relationship between brake pressure and deceleration becomes almost linear.
In the upper part of the rising slope the brake pad starts to produce smoke on its surface, so gets 'pushed away' from the disc a bit. Its friction gets less so to get more deceleration you have to push exponentially harder on the pedal.
The deceleration rate increases until the tyres start to loose grip with the road (Bmax), at which stage the brake pressure needs to be decreased quite a bit to regain grip again (ABS principal).
If the brake pressure gets increased more the deceleration rate will no more increase as the wheel is locked up. The deceleration rate is now determined by the force required to drag the tyre's rubber over the street surface.

Bigger brakes?
The graph deals already with one contentious item straight away, namely that bigger brakes or softer pads make the car stop quicker….
If the brakes are capable of locking up the wheels, then the car will stop as quick with family sedan brakes as with sporty, grippy brakes. This is because Bmax is determined by the grip between the road and the tyres.
This is also why a brake tester checks the brake force at the lock up point as you really can not get more than that brake force, with two important exceptions: *weight and grip changes*.
Bigger brakes or metallic pads do get rid of temperature quicker, so under long and repetitive braking conditions (e.g. on a circuit) they will perform better.

Slide your hand on the table
The best way to get your head around grip is the following story:

1. Put your hand on a smooth surface, slightly lean on it. Let someone grab your wrist and let that person pull your wrist till your hand starts sliding over the table (loses grip). Now imagine that your hand is the tyre and the smooth surface is the road. The force on your wrist is the car's inertia wanting to keep going while you apply the brakes.

2. Next lean harder on your hand, and see what happens with the effort (brake force) required to make your hand slip.
3. Next, lean with your hand on a rough surface like course concrete with the same weight as during the first test and see how much more effort is required now to make your hand slip.

In situation 2 and 3 the force required to make your hand slip was greater, this means that more brake pressure could have been applied onto the wheel before it started slipping. Also in situation 3, Bmax on the graph moved up.
No prizes for guessing that on a smooth wet road (situation 1) the brake distance is greater than on a dry surface with sticky tyres!
But what about weight? More weight needs more brake force to make it stop, but you can put more force on the road so that (simplistically) all evens out. How can you make weight into an advantage than from braking perspective? How about down force from spoilers? At low speed (say 100Km/h no grip with an F1 car but over 200Km/h that is a different story!
So you still want bigger brakes, well the biggest difference in changing your brakes to a different type is that the effort required on the pedal gets less for the same stopping power!
BUT at the same time if you only play around with for example the front brakes the balance between rear and front is upset as the rear still needs the

higher brake pressure…. Careful now with changing brake components!

Shocks

There is another way to change the maximum brake force you can apply on the road by down force, but without changing the vehicle's weight, and its not good!

You might remember from my previous article the suspension tester graph, where the wheel came off the suspension tester platform at about 16 Hz bounce speed.

Suspension test results of vehicle with 'nice' stiff short stroking suspension

Consider this, what will happen with Bmax in the deceleration graph when the weight on the wheel gets reduced to zero because it bounces off the road surface?

It would be the same as lifting your hand off the table while someone pulls on your wrist; it will be really easy to move your hand (no grip).

In the suspension chapter I explained that the best is to match you shocks (and even the springs) to the individual vehicle and type of road surface (smooth track vs. bumpy public road) where the vehicle gets used.

Now imagine this; some brainy fits bigger front brakes and nice stiff suspension with lowered springs on his car….. The car got a low volume certificate for road use as it seems fine doing a bump test (push the vehicle down and release again and notice that it only bounces once), and now you have to give it a WoF….. I am out!

I am sure you can point to many vehicles around you where this scenario is a fact.

CHECK OUT Page 6
…*AECS* 2010 training calendar enclosed.

Disk warp

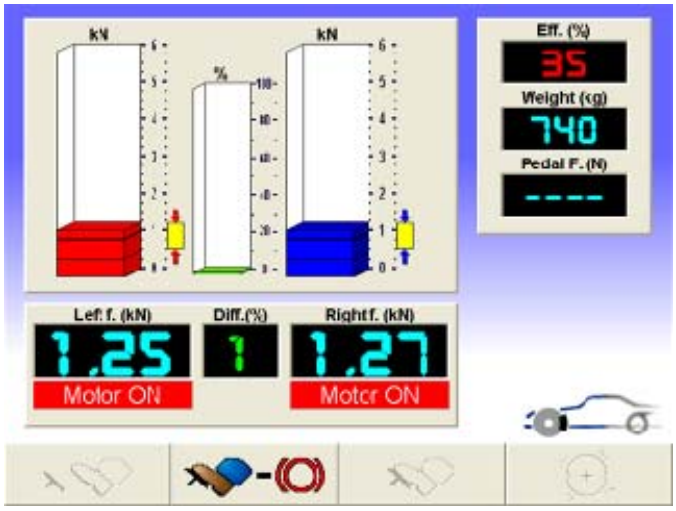
There is another way to get really easy over the point of no return (Bmax).

Disk warp or oval drums only cause a bit of uncomfy a brake shudder, right?

Well consider this, the deceleration rate of one wheel increases when the brake disk tries to pass the thick bit of the disk between the two brake pads, all good when you brake gently.

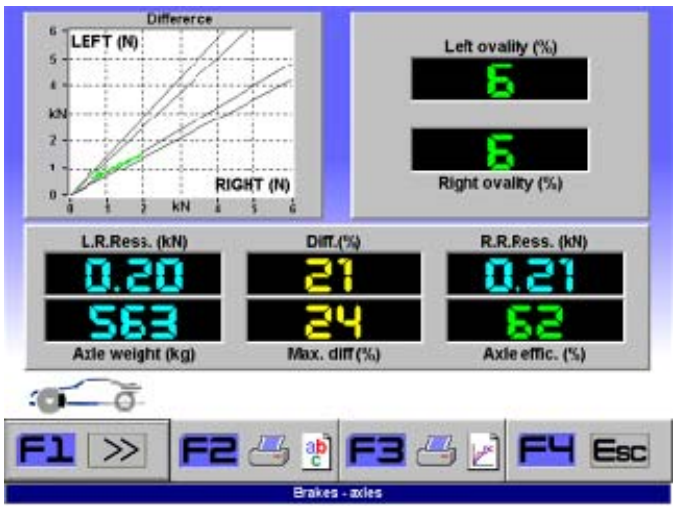
In an emergency, where you really want to stay straight and get the maximum deceleration rate out of your brakes, your deceleration rate operates very close to Bmax (this is also where ABS begins to cut in). With an uneven disk Bmax will be exceeded when the thick part of the disk moves between the two brake pads, making the tyre loose grip, never on both sides at the same time.

A good brake tester measures brake 'ovality' and makes it part of its judgement procedure.



Brake ovality testing procedure underway, note the yellow rectangles and the partial brake hold icon.

The ovality test procedure is indicated by an icon which prompts you to hold your foot steady on partial brake force during a few wheel revolutions. Theoretically the brake force should stay steady, the variations in brake force are recorded judged and displayed in a results screen.



Front axle results page of a different vehicle with 6% ovality on its brakes (not bad=green)

Judging from the deceleration graph you can judge for yourself what happens when only one wheel looses grip while the other works close to Bmax. The force on the vehicle's axle becomes uneven, the force of the slipping wheel is less than the force of the wheel which operates close to Bmax. This will make the vehicle pull in one direction, and even spin out of control.

The same can happen when the brakes operate with unequal brake force before the lock up point. The picture with the front axle brake results shows diff% and max diff%. The tester gets this information from the difference graph where the green line shows the L/R bias of the brakes. The max diff% is the maximum brake difference which could be at the beginning of the graph and the diff% is the difference at lock up.

Brake graph zoomed in.

In the graph above the difference in brake force between left and right on this car is obvious.

ABS

So ABS takes care of all these combined problems and made them go away?
Well as soon as one wheel looses grip, its rotational speed will be less than the other wheels, just like in corners and with uneven tyre pressure or with uneven tyre construction. The ABS system has tolerances for intervention and for stopping the intervention (!). To make a real long story short, you want to prevent the need for the ABS to kick in unnecessary as ABS intervention makes brake distance longer than a situation where the ABS just not needs to intervene. Also ABS is designed with a perfectly good brake/suspension system in mind. Also it can not make up for oval brakes, the hydraulic response speed is simply not fast enough, except at low speeds.

Brake testing

The electronics in the test lane is combining the static weight of the vehicle (measured on the suspension tester) with the brake force to come to a brake efficiency reading in the brake test results.
The brake efficiency is the relation between the max brake force (where the wheel starts to loose grip on the brake tester) and the weight on that wheel.
The brake efficiency of the whole vehicle is the weight on all wheels combined with the brake force of all wheels. The brake efficiency is a similar figure as the reading you get from a decelerometer.
I hope you enjoyed the article and can see the need for proper testing of your customers vehicles.

Herbert

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(trainer/research)
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AECS Training Plan 2010

ruar	March		April		May		June		July		August		Sept		October		November
1	YES meeting	1	Tauranga DMS 1(1)	1		1		1	Palmerston North Scan1	1		1		1	Private Training - Automec	1	
2	YES meeting	2	Good Friday	2		2		2	Palmerston North Scan1	2		2		2	Private Training - Automec	2	
3	YES meeting	3		3		3		3		3		3		3		3	
4	YES meeting	4		4		4		4		4		4		4		4	
5	YES meeting	5	Easter Monday	5		5		5		5	Private Training AED	5		5		5	
6		6		6		6		6		6	Private Training AED	6		6		6	
7		7		7		7	Queens Birthday	7		7		7		7		7	
8		8		8		8	Wellington AED	8		8		8		8		8	
9		9		9		9	Wellington AED	9		9		9		9		9	Auckland AIRCON
10	Private Training AIRCON	10		10		10	Private Training AED	10		10		10		10		10	Auckland AIRCON
11	Private Training AIRCON	11		11		11	Private Training AED	11		11		11	Private Training - Automec	11		11	Auckland SCAN1
12	Private Training AIRCON	12		12		12		12		12		12		12		12	Auckland SCAN1
13		13		13		13		13		13		13	Private Training - Automec	13		13	
14		14		14	Nelson DMS 1(3)	14		14		14		14	Private Training - Automec	14		14	
15		15		15	Nelson DMS 1(3)	15		15		15		15	Private Training - Automec	15		15	
16		16		16		16		16		16		16	Private Training - Automec	16		16	
17		17		17		17		17		17		17	Private Training - Automec	17		17	
18		18		18		18		18		18		18	Private Training - Automec	18		18	
19		19		19	Christchurch EMS1(4)	19		19	Auckland EMS 1(1)	19		19		19	Christchurch AIRCON	19	
20		20	Gisborne AED	20	Christchurch EMS1(4)	20		20	Auckland EMS 1(1)	20		20	Private Training - Automec	20	Christchurch AIRCON	20	
21		21	Gisborne AED	21	Christchurch AED	21		21	Auckland ATS	21		21	Private Training - Automec	21	Christchurch DMS1(3)	21	
22	Auckland AED	22	Hastings EMS 1(2)	22	Christchurch AED	22		22	Auckland ATS	22		22	Private Training - Automec	22	Christchurch DMS1(3)	22	
23	Auckland AED	23	Hastings EMS 1(2)	23		23		23		23	YES! Meeting	23	Private Training - Automec	23		23	Auckland - TBA
24	Auckand EMS1(4)	24		24	Greymouth AED	24		24		24	YES! Meeting	24	Private Training - Automec	24		24	Auckland - TBA
25	Auckand EMS1(4)	25	Anzac day	25	Greymouth AED	25		25		25	YES! Meeting	25	Private Training - Automec	25	Labour day	25	Auckland DMS1(2)
26		26		26		26		26		26	YES! Meeting	26		26		26	Auckland DMS1(2)
27		27		27		27		27	Whangarei DMS 1(1)	27	YES! Meeting	27	Private Training - Automec	27		27	
28		28		28		28		28	Whangarei DMS 1(1)	28		28	Private Training - Automec	28		28	
29	Hamilton AED	29		29		29	New Plymouth AED	29	Auckland AED	29		29	Private Training - Automec	29		29	
30	Hamilton AED	30		30		30	New Plymouth AED	30	Auckland AED	30		30	Private Training - Automec	30		30	
31	Tauranga DMS 1(1)			31				31		31						31	

No training in December

Please note: All effort has been made to ensure the training & course dates are correct, however please contact us first before publishing information from this calendar. Ph: 06-874 9077.

Created 12 Feb 2010 CML

Key:

- Sundays
- Public/school Holidays
- Date Changes
- PRIVATE Training

ABS = ABS/ Traction Control Systems seminar
EMS1(1) = Engine management Systems 1 (module 1) seminar
EMS1(2) = Engine management Systems 1 (module 2) seminar
EMS1(4) = Engine management Systems 1 (module 4) seminar (hybrid)
SCAN1 = Scan Tool diagonistics
AED = Automotive Electronic Diagnostic seminar

DMS1 (1) = Diesel Management Systems 1 Module 1 seminar
DMS1 (2) = Diesel Management Systems 1 Module 2 seminar
DMS1 (3) = Diesel Management Systems 1 Module 3 seminar
AIRCON = Air-conditioning training
ATS= Comprehensive Scope training
TBA - To be advised

Taking enrolments now for all courses.
Phone Christine
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