ANALYSIS OF RELATIVE SAFETY PERFORMANCE OF BICYCLES AND SCOOTERS

SUPPLEMENTARY REPORT ON EAGLE LARGE-WHEELED SCOOTER

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for

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Introduction

There is concern about increasing use of two-wheeled scooters on roads and footpaths. There are also concerns about small motorised two-wheeled scooters. Construction and operational restrictions are being considered. Opponents to such restrictions argue that these vehicles are no less safe than bicycles.

Vehicle Design and Research Pty Limited was engaged by VicRoads to investigate safety issues associated with two wheeled scooters. This involved comparing the relative performance of bicycles and scooters. It covered issues such as brakes and stability. Seven vehicles were evaluated for the initial project: two bicycles, one motorised bicycle, two scooters and two motorised scooters.

It was concluded that, in general, scooters are less stable and controllable than bicycles. Part of the reason was the small wheels usually fitted to scooters - these make the vehicle very susceptible to irregularities in the road surface. Also of concern is the lack of feedback through the handlebars, meaning that the rider has to concentrate on keeping the scooter stable and has little time to observe traffic hazards.

Vicroads subsequently requested that a further large wheeled scooter - the Eagle 16" Scooter - be evaluated. This supplementary report describes the outcome of that analysis.

Description of tested scooter

The Eagle 16" scooter is a large push scooter with pneumatic tyres. It has relatively large wheels (outer tyre diameter 390mm) and wheelbase (1025mm). It has front and rear caliper brakes.

Further details are provided in Appendix A.

Eagle 16" Scooter

Performance tests

In accordance with the previous work the Eagle scooter was subjected to the following performance tests:

A. Braking test in accordance with AS/NZS 1927:1998 Appendix H

This involves the rider applying the brakes to until the vehicle comes to a complete stop. Initially the vehicle will be travelling at approximately 16km/h. By using a video camera the motion is captured for later analysis. The video footage is used to double check the initial speed immediately prior to braking, and to determine both the deceleration and stopping distance. The rider commences braking once a certain marked point has been passed. An indicating light attached to the frame of the vehicle shows when the brakes are applied and this is used in the video analysis.

The standard sets a maximum stopping distance of 5.5m from 24km/h (or 16km/h for bicycles that cannot attain 24km/h). Because of the difficulty maintaining a constant speed with some of the vehicles the standard has a correction factor for speed variations. It is considered that average deceleration would be a better way of expressing braking performance. The prescribed stopping distance is equivalent to an average deceleration of 4.4 m/s^2. A smaller stopping distance is not prescribed for low speed bicycles and a 5.5m stop from 16km/h gives an average deceleration of 1.8 m/s^2.

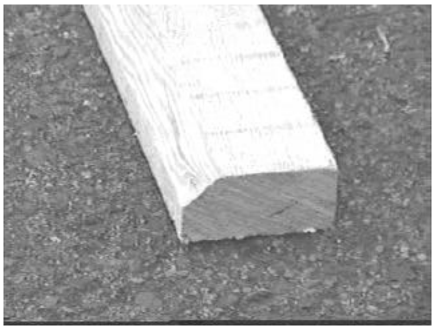
Braking test showing indicator light above front wheel.

B. Stability test in accordance with Appendix E of AS/NZS 1927:1998

The vehicle is ridden directly over a series of cleats (narrow planks), placed across the track at 1.75m spacing. The cleats are 25mm high and 50mm in width, with a 12mm chamber on the leading edge (see picture). They represent severe bumps in the road. The standard requires the vehicle to be ridden over the test course at about 5km/h as a preliminary trial and then at 25km/h (16km/h for bicycles incapable of such speeds). Because of the uncertainty about the stability of each vehicle the tests were conducted at approximately 5, 10 and 15km/h. If the tester considered it safe the test at 25km/h was then attempted.

45^o cleats for stability test (Holstar Scooter)

Subject to reasonable performance with the cleats set at 90^o, they were then set at 45^o to the direction of travel. This test configuration is not prescribed in the standard but was considered necessary in order to introduce asymmetric loading into the steering system.



Close up view of cleat

C. Manoeuvrability tests in accordance with TRRL LR500.

The rider must negotiate their way in a zig-zag pattern between 6 marker cones, each placed 1.5m apart along a straight line. The test is conducted at slow speed (about 5km/h).

A second manoeuvrability test is conducted with cleats between the marker cones.

D. Top speed test

The standard regards the top speed of a bicycle as the equivalent road speed when the highest gear ratio is selected and the pedals are turned at a rate of 1 revolution per second.

Manoeuvrability course with cleats

The top speed of non-motorised scooters is likely to be highly dependent on rider skill and concentration and the inherent stability of the vehicle. All two-wheeled vehicles are subject to several types of instability (see "Design Issues"). Some of these are speed dependent. The design intention should be that no instability occurs over the normal range of speed of the vehicle. A difficulty is defining this speed range - higher speeds, at which instability develops, may only be attained when descending steep hills.

No attempts were therefore made to determine the "top speed" of non-motorised vehicles, although it was considered that a practical top speed had been reached with some vehicles in the stability tests. Further comments are provided in the section "Design Issues".

Test Methods

A simple, lightweight fifth wheel device was developed for the purpose of the tests. It used an electronic bicycle speedometer. The intention was to give the rider an indication of road speed just prior to the commencement of a test run. In practice, it was only used on the braking and top speed tests. The wheels bounced around too much during the stability tests. These tests were therefore conducted after the brake tests so that the rider had a good feel for the vehicle when moving at around 16km/h. Subsequent video analysis showed that a reasonable range of speeds was achieved.

All on-road tests were assessed by video taping the event from the side and analysing the resulting digital video. This enabled initial speeds and braking distances to be determined. Theoretical analysis indicated that resulting measurement errors were minimal since key measurements were almost perpendicular to the line of sight. The video rate was 25 frames per second, which is equivalent to 200mm at 16km/h.

For the braking tests a bright light was fitted to the vehicle and was activated whenever the braking control was applied. The instant of application of the brakes was therefore evident on the video.

Stability factors were assessed subjectively, based on the tester's determination of the reasonable limits of performance of the vehicle and the guidelines set out below. Tests were curtailed if there were any signs of severe instability.

Measurements of steering geometry were analysed for determination of the theoretical limits on stability (based on bicycle theory).

Stability assessments

Each of the tests was assessed for stability and control. The braking test also included an assessment of the perceived effectiveness of the brakes. The following guidelines were used for the assessment.

Stability

Unstable motion is regarded as a tendency for the vehicle to deviate from the desired direction of travel. This includes unintended steering action, sideways skidding of the tyres and body roll.

Good - the vehicle is stable at all times and does not require alertness on the part of the rider

Adequate - the vehicle is stable most of the time but the rider needs to be alert

Marginal - the vehicle is unstable for most of the time and requires constant rider attention

Poor - the vehicle is unstable and there is a high risk of a fall

Aborted - the test could not be completed due to instability

Control

The ability of the rider to control the direction and speed of the vehicle

Good - steering and braking controls are well modulated with good feedback to the rider

Adequate - steering and braking controls are well modulated but feedback is lacking

Marginal - steering or braking is poorly modulated but some degree of control is available

Poor - steering or braking is poorly modulated but and control is only possible with high skill. The control is difficult to operate or easily fumbled.

Aborted - the test could not be completed due to poor control.

Braking effect

This is based on the rider's perception of the degree of braking available. This includes factors such as imminent (or actual) wheel lock-up and the balance between front and rear brakes.

Results for Eagle Scooter

Performance Tests

Braking tests

Appendix B details the results of the braking tests.

The Eagle performed exceptionally well in the braking tests in terms of stopping distance. Average deceleration was $7 m/s^2$. This is well in excess of the Australian Standard (for bicycles) and better than all other vehicles tested - the next best was the mountain bike with an average deceleration of $4.57 m/s^2$. The front and rear caliper brakes are extremely effective on the Eagle scooter. This did however, cause some problems for control, which was rated 'marginal' for four of the braking tests and 'acceptable' for the other (when the tester deliberately reduced braking effort on the front brakes). In the four tests rated 'marginal' the scooter tipped onto its front wheel.

Tipping onto front wheels during brake test

Stability tests

Results of stability tests are set out in Appendix C. Note that the first low-speed test is intended as a preliminary test. The following comments refer to the tests at higher speeds.

The Eagle scooter was rated good for stability and control in the 90^o cleat tests but stability dropped to adequate in the 45^o cleat tests.

Manoeuvrability tests

The Eagle scooter was rated adequate for stability and adequate for control with and without cleats. Note that the rider needed to push with his foot on the ground to maintain speed and this assisted in stability and control.

Top speed tests

With considerable effort the Eagle scooter reached 19km/h during one of the brake tests. Stability and control were good at this speed.

Design Issues

Steering geometry and stability

References on bicycling science point out the importance of front wheel trail for safe, stable riding. Trail is the distance between the centre of the tyre contact patch and the point where the steering axis intersects the ground. AS1927 sets limits for steering head angle (between 65^o and 75^o from the horizontal) and a dimension related to trail .

The standard prescribes a limit on the length of the vertical side of a triangle formed by the steering axis and a vertical line through the axle - for a conventional 26" wheel this means the trail should be between 30mm and 120mm. Generally bicycles have a trail about the middle of this range.

Whitt and Wilson provide a method of calculating stability from steering geometry, based on steering head angle, wheel diameter and fork offset (horizontal distance from the front axle to the steering axis). These calculations have been applied to the range of vehicles tested, although caution should be used in interpreting the results because the method was not intended to be applied to scooter configurations.

Table 2. Steering Geometry Calculations

DESCRIPTION	Wheel Dia mm	Steer Angle	COMPLIES WITH AS?	Trail mm	ASMax mm	ASMin mm	COMPLIES with AS?	Offset	Mu
GIANT MTN BIKE	665	70	Y	76	120	30	Y	45	-2.9
ROTARY CRUISER	665	70	Y	80	120	30	Y	41	-3.0
TRACKER ELECTRIC SCOOTER	190	75	Y	30	34	9	Y	-5	-4.3
VIPER BMX	500	75	Y	50	90	23	Y	17	-2.7
TAMI PETROL SCOOTER	210	80	N	0	38	9	N	19	-0.1
HOLSTAR SCOOTER	315	70	Y	20	57	14	Y	37	-1.5
RAZOR FOLD-UP SCOOTER	100	82	N	0	18	5	N	7	-0.1
EAGLE SCOOTER	390	70	Y	45	70	18	Y	26	-2.9

"Mu" is a stability factor derived by Whitt and Wilson. They state "experience indicates that bicycles have good steering characteristics when Mu is between -1 and -3". A Mu approaching or exceeding zero indicates unstable characteristics.

This analysis suggests that the Eagle scooter has steering characteristics that would be desirable on a bicycle.

Steering trail is associated with the restoring moment that occurs when the front wheel is turned slightly at speed. With a good design of bicycle this is felt as feedback through the steering wheel. In other words, the more the rider turns the handlebars the higher the resistance to turning becomes. This is a very important feedback mechanism that enables bicycle riders to remain stable and upright without too much concentration - this issue is discussed further under "Human factors".

In effect, over a range of speeds, this steering characteristic is self correcting - a tendency to veer to one side results in steering action that brings the bicycle back to the centre. It is the reason that most bicycles can be ridden with hands off the handlebars. In contrast all of the scooters tested, including those with relatively large trail, were found to be unstable when any attempt was made to let go of the handlebars. This is not surprising since the handlebars need to be held to control roll as well as yaw.

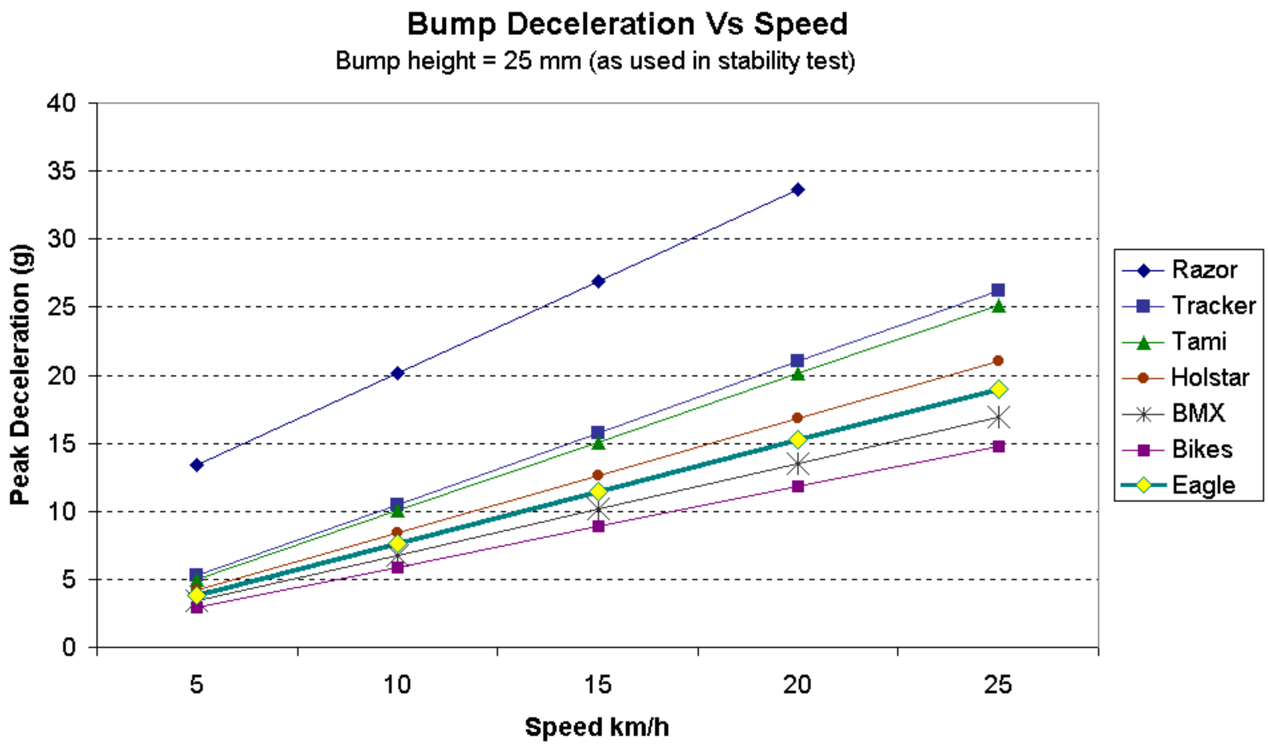
The stability theory predicts that instability will become more of a problem with increased speed. The three bicycles and the Holstar and Eagle scooters did not experience this degradation with increased speed.

Due to their configuration it is doubtful whether any significant improvements could be made to the design of the tested scooters in order to raise their stability performance to that of bicycles.

Self-correcting steering is the simplest form of stability applying to two-wheeled vehicles and it is applicable to all speeds. At higher speeds other modes of instability come into play. These are typically more a concern with motorcycles and high performance racing bicycles and are unlikely to be encountered with conventional bicycles and scooters. An exception might be where speed builds up during a long descent.

Bumps

The stability tests (involving driving across cleats) revealed that small-wheeled vehicles are much more sensitive to bumps than vehicles with larger wheels. It can be demonstrated theoretically that the (horizontal) deceleration forces generated when a wheel strikes a bump are proportional to the square root of the bump height divided by the wheel diameter. The graph shows the theoretical response of each vehicle to the 25mm bump used in the stability test. This assumes high stiffness in the tyres. In practice, pneumatic tyres tend to deform to the profile of the bump and therefore the responses for pneumatic tyres can be expected to be better than those derived below.



Theoretical bump response of each vehicle

During the stability tests the Tracker and Tami scooters experienced stability and control deterioration when the speed increased from 10 to 15 km/h. From the graph this suggests that a peak deceleration around 15g was sufficient to cause problems associated with poor bump response. Applying this notional value to the other vehicles the Razor would be limited to no more than 5km/h, the Holstar scooter to about 18km/h and the *Eagle scooter*, BMX bike and large bikes to 20km/h or more. This assumes that the maximum bump height encountered in the riding environment is 25mm.

Lights

The Eagle scooter had no lights or reflectors. *For bicycles* lights are optional and reflectors are compulsory under the Australian Standard.

Human Factors

Control of vehicle

All vehicles had conventional handlebars for steering control. During the performance tests the scooters were found to be more sensitive to steering input than bicycles.

All vehicles except the Razor used hand levers for brake control. These were all well modulated but control was limited by other factors such as stability, skidding and, in the case of the Eagle scooter, the tipping of the vehicle.

Rider cognitive tasks

The task of controlling a vehicle is very demanding. Vehicle direction and speed must be monitored and controlled. The road environment and other road users must be continually assessed and control action taken, if appropriate. These tasks can become overwhelming in an emergency situation.

Two wheeled vehicles place additional demands on the rider because of the need to maintain balance. The two wheeled vehicle is much less forgiving if control momentarily lapses and road user protection in the event of a collision is minimal.

With the range of scooters that we tested it is evident that the time it takes for the vehicle to veer out of control is much less than that for a conventional bicycle. The rider needs to constantly monitor and adjust the vehicle. Compounding this problem is the lack of steering feedback with a typical scooter. With a bicycle it is possible to ride it for a short time with eyes closed. This is because the rider receives feedback from the steering system.

In general, with a scooter the only feedbacks to the rider are visual and the sense of balance. Since changes need to be detected in order to recognise destablising motion the rider must be constantly aware of changes. This raises serious dilemma when the vehicle mixes with other traffic - particularly cars - because the rider must choose between monitoring the vehicle and monitoring other traffic. They cannot afford the luxury of looking around for more than a fraction of a second to assess the traffic situation. In contrast, bicycle riders can take a second or two to look around. This is a fundamental limitation to the ability of these types of scooters to mix with other traffic.

Road Environment

Mixing with traffic

For the types of scooters tested the rider is unable to devote sufficient attention to other traffic. They are therefore more likely to get into a dangerous situation than the rider of a conventional bicycle. The Eagle scooter was found to be better than the other scooters in this regard but was still noticeably worse than the large bicycles.

The overall height of a rider/scooter combination is usually less than that of a bicycle so other motorists are less likely to see a scooter rider. Another concern is that a common mode of falling off a scooter is a sudden and severe sideways motion. There may, therefore, be more likelihood of a scooter rider falling into the path of a car.

Impacts between cars and erect scooter riders are likely to be more severe than with bicycles because the scooter rider’s torso is closer to the ground and therefore vulnerable to direct impact. The risk of head impacts with colliding vehicles is likely to be similar, although the body kinematics would be different.

In summary, it is considered that none of the tested scooters is suitable for mixing with normal traffic on public roads. The non-motorised scooters could continue to be used for recreational purposes where there is only slow-moving traffic. Specialised facilities such as bicycleways might provide a safer environment for commuter travel using scooters.

Mixing with pedestrians

Very little research appears to have been done into the risk to pedestrians from collisions with riders of recreational devices. Most research seems to concentrate on injured riders who were admitted to hospital. As a general rule any situation where pedestrians are likely to be involved in collisions at 10km/h or more should be avoided. This includes joggers, bicycles, scooters, skateboarders and in-line skaters. Higher speeds present problems for collision avoidance (pedestrians don't have time to get out of the way and riders don't have time to dodge a hazard) and injury avoidance. Collisions with unyielding objects at such speeds can cause fractures and severe head injuries (Henderson and Paine, 1997). With frail pedestrians there is extra hazard from being knocked over, or falling over when trying to avoid a collision.

Conclusions

The Eagle 16" Scooter complied with the brake performance and the steering geometry requirements specified in AS1927. It was rated good for stability but marginal for control in braking tests. It was considered too easy to cause the rear wheels to lift off the ground during heavy braking. Despite this concern the braking performance, in terms of stopping distance, was noticeably better than all other vehicles tested, including bicycles and it is possible that, with experience, rider modulation of the brakes could be improved.

The Eagle was rated good for stability and control in the stability tests prescribed in that standard. Stability dropped to acceptable with the cleats at 45^o. It was rated adequate for stability and control in the manoeuvrability tests. The Eagle rated better than the BMX bicycle for these tests.

Overall, the Eagle was considered to be the best performing of all of the scooters tested. There remain, however, serious concerns about the ability of this scooter to mix safely with other road traffic. This is due in part to the fundamental design of the scooter, which requires much greater rider attention to maintain directional control than a conventional bicycle. In many respects the Eagle scooter was comparable in performance to the BMX bicycle but our tests suggest that neither has the favourable handling characteristics of the larger bicycles.

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Appendix A Vehicle Specifications

TEST CODE	DESCRIPTION
A	26" Mountain bicycle
B	26" Motorised bicycle
C	Motorised scooter with mid-size tyres
D	BMX bicycle
E	Motorised scooter with large tyres - no seat
H (E)	Motorised scooter with large tyres and a seat
F	Scooter with large tyres
G	Scooter with small solid tyres
I	Eagle Scooter with 16" wheels

Details for the Eagle scooter are set out overleaf. See the previous report for details of other vehicles.

Technical Specifications: I - Eagle 16" Scooter

General

Make and Model: Eagle 16" Scooter

Description: Large push scooter with pneumatics wheels.

General view of vehicle

Braking system

Front and rear lever operated caliper brakes

Caliper brake - rear wheel

Power

Push

Maximum speed on level: About 18km/h

Mass and Dimensions

Unladen mass: Front 5kg Rear 7 kg
Total 12 kg

Laden mass: Front 36 kg Rear 39 kg
Total 75 kg

Front % of total: 48 %

Estimated height of centre of mass (laden):
850 mm

Wheelbase: 1025 mm Height/wheelbase: 83 %

Steering geometry

Steering head angle: 70 degrees

Trail: 45 mm

Vertical intercept: 130 mm

Tyre outer diameter: 390 mm

Rim outer diameter: 310 mm

Tyre type: Pneumatic

Tyre size: 16x1.75

Comments: Well designed steering setup. Very effective brakes.

View of steering geometry

Appendix B - Brake Test Results

Table 2 Braking Tests

VEHICLE	SPEED km/h	ADJ STOP DIST m	AV.DEC m/s/s	STABILITY	CONTROL	EFFECT
GIANT MTN BIKE	18	2.09	4.73	G	G	G
GIANT MTN BIKE	19	2.14	4.62	G	G	G
GIANT MTN BIKE	19	2.14	4.61	G	G	G
GIANT MTN BIKE	18	2.14	4.62	G	G	G
GIANT MTN BIKE	18	2.30	4.30	G	G	G
		Av	4.57			
ROTARY CRUISER	19	2.39	4.13	M	M	A
ROTARY CRUISER	19	2.11	4.69	M	M	A
ROTARY CRUISER	17	2.08	4.74	M	M	A
ROTARY CRUISER	18	2.26	4.36	M	M	A
		Av	4.48			
TRACKER ELECTRIC SCOOTER*	16	3.26	3.03	P	P	M
TRACKER ELECTRIC SCOOTER*	16	3.26	3.03	P	P	M
TRACKER ELECTRIC SCOOTER*	17	3.27	3.02	P	P	M
TRACKER ELECTRIC SCOOTER*	16	3.27	3.02	P	P	M
		Av	3.03			
VIPER BMX	19	2.69	3.67	G	G	A
VIPER BMX	17	2.50	3.96	G	G	A
VIPER BMX	18	2.58	3.84	G	G	A
		Av	3.82			
HOLSTAR SCOOTER	17	2.63	3.76	A	A	M
HOLSTAR SCOOTER	16	3.19	3.09	A	A	M
HOLSTAR SCOOTER	17	2.29	4.32	A	A	M
HOLSTAR SCOOTER	18	2.70	3.65	A	A	M
		Av	3.71			
RAZOR FOLD-UP SCOOTER*	18	2.60	3.80	M	P	P
RAZOR FOLD-UP SCOOTER*	18	3.03	3.26	M	P	P
RAZOR FOLD-UP SCOOTER*	16	2.82	3.50	M	P	P
		Av	3.52			
TAMI PETROL SCOOTER*	18	3.53	2.79	A	A	M
TAMI PETROL SCOOTER*	18	3.42	2.89	A	A	M

VEHICLE	SPEED km/h	ADJ STOP DIST m	AV.DEC m/s/s	STABILITY	CONTROL	EFFECT
TAMI PETROL SCOOTER*	18	3.63	2.72	A	A	M
TAMI PETROL SCOOTER*	17	3.48	2.84	A	A	M
TAMI PETROL SCOOTER*	18	3.15	3.14	A	A	M
		Av	2.88			
TAMI WITH SEAT*	16	2.77	3.56	M	A	M
TAMI WITH SEAT*	17	3.01	3.28	M	A	M
TAMI WITH SEAT*	16	2.65	3.73	M	A	M
TAMI WITH SEAT*	19	2.83	3.48	M	A	M
TAMI WITH SEAT*	18	2.71	3.65	M	A	M
		Av	3.54			
EAGLE SCOOTER	16	1.30	7.62	G	M	G
EAGLE SCOOTER	17	1.23	8.06	G	M	G
EAGLE SCOOTER	14	1.60	6.18	G	M	G
EAGLE SCOOTER	16	1.61	6.14	G	A	G
EAGLE SCOOTER	15	1.34	7.35	G	M	G
		Av	7.07			

* Rear brake only

Key

G	Good
A	Adequate
M	Marginal
P	Poor
X	Aborted

Appendix C - Stability tests

1. Cleats at 90°

VEHICLE	SPEED km/h	STABILITY	CONTROL	NOTE
GIANT MTN BIKE	7	G	G	
GIANT MTN BIKE	12	G	G	
GIANT MTN BIKE	15	G	G	
GIANT MTN BIKE	16	G	G	
GIANT MTN BIKE	20	G	G	
GIANT MTN BIKE	24	G	G	
ROTARY CRUISER	14	A	G	
ROTARY CRUISER	20	A	G	
TRACKER ELECTRIC SCOOTER*	7	P	X	Unable to control low speed
TRACKER ELECTRIC SCOOTER*	10	P	M	
TRACKER ELECTRIC SCOOTER*	15	P	P	
VIPER BMX	8	A	M	
VIPER BMX	12	M	M	
VIPER BMX	22	M	M	
TAMI PETROL SCOOTER*	5	A	A	
TAMI PETROL SCOOTER*	10	M	M	
TAMI PETROL SCOOTER*	14	P	M	
HOLSTAR SCOOTER	4	A	A	
HOLSTAR SCOOTER	15	A	A	
HOLSTAR SCOOTER	16	A	A	
RAZOR FOLD-UP SCOOTER*	10	X	X	
RAZOR FOLD-UP SCOOTER*	10	X	X	
TAMI WITH SEAT*	7	M	M	
TAMI WITH SEAT*	14	M	M	
EAGLE SCOOTER	7	A	G	
EAGLE SCOOTER	16	G	G	
EAGLE SCOOTER	17	G	G	
EAGLE SCOOTER	18	G	G	

2. Cleats at 45°

VEHICLE	**SPEED km/h**	**STABILITY**	**CONTROL**
GIANT MTN BIKE	7	G	G
GIANT MTN BIKE	14	G	G
GIANT MTN BIKE	22	G	G
ROTARY CRUISER	6	A	A
ROTARY CRUISER	7	M	A
ROTARY CRUISER	10	A	A
ROTARY CRUISER	19	M	A
TRACKER ELECTRIC SCOOTER*	8	M	A
TRACKER ELECTRIC SCOOTER*	14	P	M
VIPER BMX	7	A	G
VIPER BMX	26	M	M
TAMI PETROL SCOOTER*	6	M	P
TAMI PETROL SCOOTER*	16	P	P
TAMI PETROL SCOOTER*	23	P	P
HOLSTAR SCOOTER	7	A	A
HOLSTAR SCOOTER	16	M	A
HOLSTAR SCOOTER	17	M	A
RAZOR FOLD-UP SCOOTER*	9	X	X
TAMI WITH SEAT*	11	M	M
TAMI WITH SEAT*	14	P	P
EAGLE SCOOTER	11	A	A
EAGLE SCOOTER	13	A	G
EAGLE SCOOTER	19	A	G
EAGLE SCOOTER	14	A	G

Appendix D - Manoeuvrability Tests

Manoeuvrability tests based on TRRL LR500 (UK National Cycling Proficiency Test)

The cleats were 20mm high, 40mm wide and had a 12mm radius edge.

VEHICLE	**CLEATS**	**STABILITY**	**CONTROL**	**NOTE**
GIANT MTN BIKE	NO	A	G	
GIANT MTN BIKE	YES	A	G	
ROTARY CRUISER	NO	A	M	
ROTARY CRUISER	YES	M	M	TOO CUMBERSOME
TRACKER ELECTRIC SCOOTER*	NO	X	X	ABORTED
TRACKER ELECTRIC SCOOTER*	NO	M	M	NO POWER
VIPER BMX	NO	G	A	ON SEAT
VIPER BMX	NO	G	G	OFF SEAT
VIPER BMX	YES	A	M	ON SEAT
VIPER BMX	YES	A	A	OFF SEAT
TAMI PETROL SCOOTER*	NO	G	A	
TAMI PETROL SCOOTER*	YES	M	M	
HOLSTAR SCOOTER	NO	G	A	
HOLSTAR SCOOTER	YES	G	A	
RAZOR FOLD-UP SCOOTER*	NO	M	M	
RAZOR FOLD-UP SCOOTER*	YES	X	X	
TAMI WITH SEAT*	NO	M	P	
TAMI WITH SEAT*	YES	M	P	
EAGLE SCOOTER	NO	A	A	
EAGLE SCOOTER	YES	A	A	

Key

G	Good
A	Adequate
M	Marginal
P	Poor
X	Aborted