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Handling track requirements

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J.R. Ellis, M.Sc.(Eng.), Ph.D., A.M.I.Mech.E., M.S.A.E.

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When the handling qualities of a vehicle are to be assessed, it is desirable that the test procedure enables the effects of the main vehicle parameters to be determined separately. The tests will consist of steady state and transient response determination. Modern instrumentation techniques which enable the vehicle accelerations, roll angle, and rate of turn to be recorded provide a means of measuring both steady state and transient responses. A portable 'handling' unit with lateral accelerometer, fore and aft accelerometer, roll position gyroscope, and yaw velocity gyroscope, together with a film or tape recorder, is a perfectly practical proposition.

Steady state tests

Skid pan tests as demonstrated by Olley (Ref. 1), in which the vehicle runs on a constant radius turn at various speeds, are of limited value. In these tests, high lateral accelerations are developed at relatively low forward speeds, roll angle is excessive, as is the power demanded to maintain speed on the tight turn. These effects, particularly the power requirement, with its attendant reduction in tyre lateral force coefficients, accentuate the differences between various types of vehicles.

The steady state turning character of a vehicle is dependent on

a) radius of turn
b) forward speed
c) roll angle
d) wheel traction

To separate these effects, it is desirable that tests be carried out on various radii of track, with power throughput, braking, and free-rolling at all speeds up to the maximum of which the vehicle is capable. In order to permit assessment under 'real road' conditions, the maximum curve radius should be such that the least radial acceleration (U^2/R) is about 5 ft/sec^2 at the maximum speed of the vehicle.

By conducting a series of these steady state tests at varying speeds on fixed radius curves, it is possible to correlate the results and obtain, for example, the yawing velocity, or rate of turn response, with constant vehicle roll angle.

The large radius of turn required to satisfy the $U^2/R = 5$ ft/sec^2 requirement, (8,000 ft at 200 f.p.s.) need not be expensive in terms of physical space since the length along the curve required to obtain a steady state is about 600 ft., or an arc of only a few degrees. The run up requirements for the high speeds suggest that this facility can only be obtained when the handling track is designed in conjunction with a high speed banked circuit.

Transient tests

A number of transient vehicle response tests are possible. The effect of step steering input can be assessed on the entry and exit to the steady state response curves. A wide, (120 ft) straight and level runway is needed for sinusoidal steering inputs. The same runway can be used for free-steering responses in which the steering wheel is released immediately after being displaced from the straight ahead position.

External influences

Road camber and wind gusts can be simulated on a test road. A length of road with a known camber (about 5°) must be wide enough to allow the vehicle to curve at a steady angle of run off (50 ft) under free control. A guiding line is required to provide a reference for measurement of steering wheel angle required to hold a straight path perpendicular to the camber. 300 ft.of road is adequate.

Gust effects are difficult to obtain without the aid of artificial wind generators. One possibility, which requires that the test day is selected carefully, is to erect a small tunnel over the test track where the track runs perpendicular to the prevailing wind. Motor-way experience suggests that the effect of a sharp edged gust will be experienced as the vehicle leaves the tunnel.

Tests, particularly those at the higher speeds, should be repeated under wet conditions.

Track surrounds

Some provision to ensure the safety of the vehicle and occupants is necessary. A smooth, obstruction-free surface extending at least 300 feet from probable danger points is desirable. This surface will need constant repair and attention if it is sown with grass; ruts etc. should be levelled.

Summary

Test track requirements for vehicle handling suggest that the 108 ft. radius skid pan is inadequate. Curves of varying radii up to 8000 ft. are necessary. The curve length required is not more than 600 ft. High speed turns will, necessarily, form part of a general high speed, banked track facility. The majority of the radii needed can be found on typical airfield perimeter tracks and runways.

A 120 ft. wide, straight track is required for measurement of vehicle responses to sinusoidal steering input, and 'free control'.

Reverse curvature tests require opposite hand curves joined by a known transition path.

Camber sensitivity testing requires a strip of track 50 ft. wide by 300 ft. long of a known constant camber, five degrees is suggested as a reasonable value of the camber.

Wind gusts are difficult to simulate, a tunnel is suggested as one of the cheaper methods of simulation.

Tests should be conducted in wet and dry conditions. Safety requirements suggest 'run off' areas near probable danger points.