CAPTIF DYNAMIC WHEEL FORCES
MEASUREMENT AND ANALYSIS SYSTEM

by

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OVERVIEW

Testing work at the Canterbury Accelerated Pavement Testing Indoor Facility (CAPTIF) has in the past characterised the vehicle loading on the pavement only by the static loads of the "vehicles". The facility was designed to apply realistic dynamic loading and so the vehicles have been fitted with standard heavy vehicle suspension components. However, to date dynamic wheel forces have not been monitored. The system described in this document consists of the hardware and software necessary to monitor and analyse the dynamic wheel force behaviour of the CAPTIF "vehicles".

The monitoring system is based on the assumption that a CAPTIF "vehicle" can be regarded as a simple system of two masses connected by springs and dampers to each

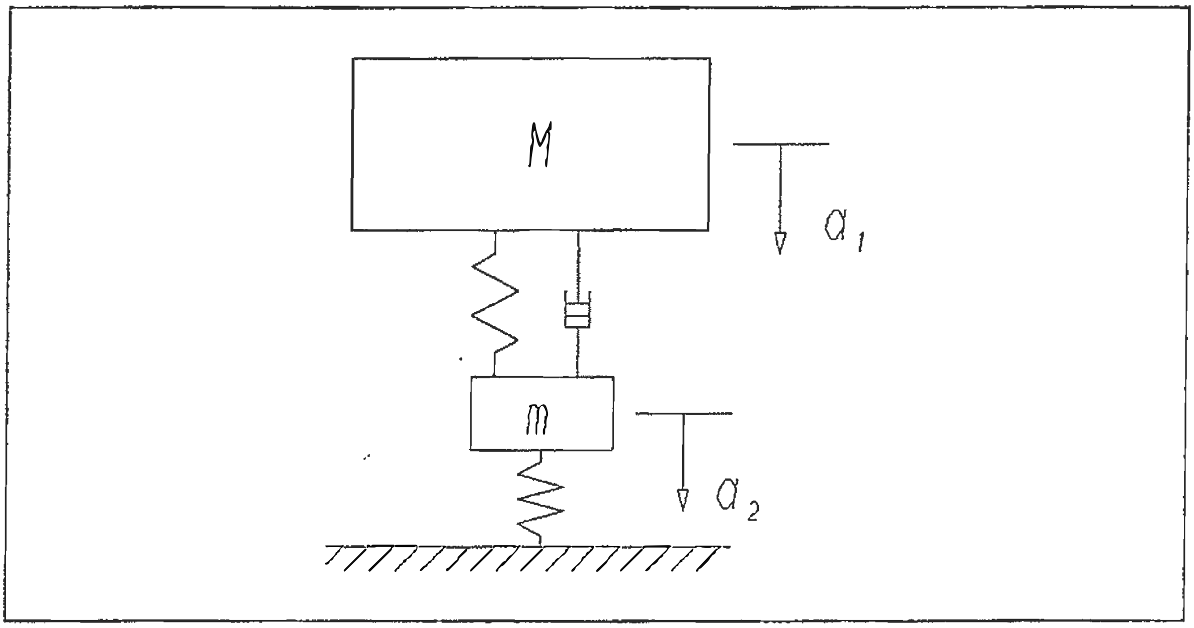

Figure 1 Model of CAPTIF "vehicle" as a dynamic system

other and to the ground as shown in figure 1. The nature of the springs and dampers is not important as from Newton's laws the wheel force F can be written as

$$F = M.a_1 + m.a_2$$

Thus, if we know the sprung mass, M, the unsprung mass, m, and we measure the accelerations of both these masses it is a relatively simple matter to calculate the wheel forces.

The monitoring and analysis system has been developed with two purposes in mind and consequently two different wheel force measurement tests are envisaged. The first purpose is to be able to monitor the dynamic wheel forces that a test pavement is being subjected to. The second purpose is to monitor the dynamic behaviour of the "vehicle" itself and so determine whether it characteristics are changing with age or usage. This will be useful for comparing results of different tests done at different times and also for comparing suspension characteristics should different suspensions be fitted to CAPTIF. As the outcome of the first type of test is dependent on the pavement profile it is not suitable for the second purpose.

TEST PROCEDURES

The test for monitoring the dynamic wheel forces applied to a particular pavement is based on constant speed operation of the facility. The test speed is a variable which can be adjusted but it is expected that it would be at some normal operating speed. To undertake the test CAPTIF would be set to run at the desired test speed. Once this speed was achieved, the monitoring system records the instrumentation for some small predetermined number of cycles.

This test measures the interaction of the CAPTIF "vehicle" with the pavement and is a function of load, speed, suspension type and condition, tyre type, configuration and inflation pressure, and pavement profile. All of these factors must be considered when using this test as part of a research project or programme. A typical application would be to monitor the change in wheel forces with pavement deterioration. Thus, all factors except pavement profile would be constant from one measurement to the next.

The second type of test is aimed at characterising the "vehicle" dynamics independently of road profile. To do this a standard repeatable excitation force is suggested. The EC directive on an "equivalent-to-air" rating for suspensions specifies a test procedure which involves have the axle traverse a "standard" hump at crawl speed and measuring the wheel force signal downstream of this hump. Figure 2 illustrates the dimensions of this

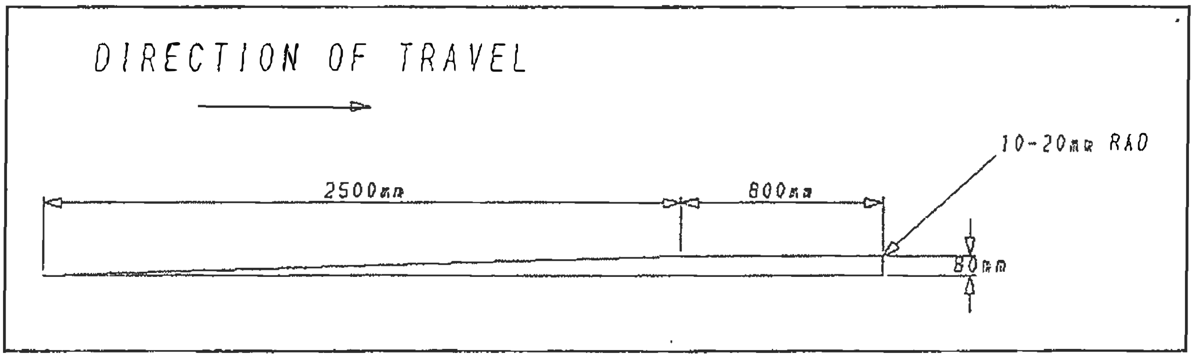

Figure 2 EC suspension test ramp

"standard" hump. The natural frequency and damping calculated from this signal are used to characterize the suspension. Although there is no reason to consider this hump superior to any other perturbation, there are advantages to having some compatibility with international data. Thus, for the second test, an EC hump should be placed in the path of the CAPTIF "vehicles" and the speed should be set to a crawl value, say 5 km/hr. This low speed is intended to ensure that no dynamic behaviour is induced in the "vehicles" because of the pavement profile. For this reason, although the pavement profile should not affect the results, it is desirable not to use a very rough pavement. Similarly, although (provided the speed is low) the actual speed should not affect the results, it is desirable to settle on a value and use it for all tests.