SHOCK AND VIBRATION ENVIRONMENTS
*Road simulator tests**

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Abstract

SHOCK AND VIBRATION ENVIRONMENTS: ROAD SIMULATOR TESTS.

The study was undertaken as an element of a programme directed at determining the shock and vibration environments encountered during the normal transportation of nuclear materials. Previous data for a large number of shipments have been reviewed and over-the-road tests have been conducted. These previous efforts have resulted in a shock-spectra description which bounds the environments anticipated during normal shipment. The study seeks to extend these results. This goal is being accomplished with road simulator experiments and the continued development of an analytical model. The results will be an improved ability to predict the shock and vibration environment for a given shipment and an improved ability to design critical elements of the system, such as tie-downs. The paper discusses the experimental programme. The experiments consisted of two road simulator tests. The system response and the known input resulted in defined frequency response functions for the system. These results provide the final data required for the development and verification of an analytical model.

Road Simulator Tests

The tests were conducted on the Fruehauf Research and Development Division's road simulator, which is equipped with six electro-hydraulic servo-controlled actuators. The hydraulic actuator capacity is a ±5 inch stroke over a nominal road frequency range of zero to fifty hertz.[1]

These tests utilized separate cask/trailer systems of a similar nature and load to verify the ability of the analytical model to respond correctly to structural changes. The first system consisted of a White Freight Liner tractor with leaf-spring suspension and a Fruehauf drop frame trailer. The load was a NuPac 7D-3.0, Type B cask loaded with 5400 lb of sand.[2]

The second system tested was a Transport Systems drop frame trailer loaded with a Chem-Nuclear Systems Inc. 14-17D cask. This cask had a load of 5000 lb.

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[1] 1 inch = 25.4 mm.

[2] 1 lb = 0.4536 kg.

Three types of roads were simulated for these tests. These are a smooth primary road, a spalled primary road and a rough secondary road. The smooth primary road was derived from a section of I-75 south of Detroit. The road was driven over at a speed of 55 mph.[3] The surface was smooth asphalt over original concrete. There were slight undulations due to the joints underneath.

The spalled primary road was derived from a section of I-94 within the Detroit city limits. The road was driven over at a speed of 45 mph. The surface is concrete which was cracked and broken after a harsh winter.

The rough secondary road was derived from a section of 31 Mile Road driven over at 40 mph. This is a county road north of Detroit whose surface is rough, old and weathered asphalt.

The transient or shock environment was derived from a section of the Bendix Test Track in South Bend, Indiana. The test track includes diagonal bumps, undulating road, chatter bumps and a 4 inch deep chuck hole.

Instrumentation

The response data included accelerations and loads. Thirteen accelerometers monitored vertical accelerations during the test and two load cells monitored tie-down loads. Nine accelerometers were located on the centerline of the trailer and cask and defined the mode shapes, frequencies and amplitudes for the analytical model. Three of these accelerometers monitored the response at the axles, two monitored the response at the top of the cask and the remaining four were on the trailer. The four additional accelerometers monitored roll at the tandem, trailer bed and cask top.

The two load cells provided data on the tie-down loads and a further check for the analytical model.

The tests included a full range of simulated random vibration and shock environments such as would be encountered during normal transport.

Test Data

In this section the test data is reviewed and the primary response modes of the system are shown. The data is also being used to demonstrate the effects of road roughness and structural changes on system response.

Future Work

In order to validate an analysis method, verification with the road simulation tests will be used. The finite element model will contain suspension elements, trailer and tractor

[3] 1 mile = 1.609 km.

frame detail, along with cask and tie-down elements. Analysis response quantities will be compared with the corresponding measured responses. The verified model will subsequently be used in defining the normal transportation environment and, hence, will be useful in establishing design criteria for cask tie-downs.