HVE Features Available to use in HVE-compatible Programs

HVE ABS Simulation Model *(Available to use in SIMON)*

The HVE ABS Simulation model is a general purpose model, available for use in the SIMON vehicle simulation model. The model is applicable to the design of ABS systems, as well as the study of loss-of-control crashes of ABS-equipped vehicles. The HVE ABS model works like the ABS system on an actual vehicle: It uses an algorithm to modulate the brake pressure at each wheel. The algorithm is designed to maximize brake force and prevent excessive wheel slip.

Two ABS algorithms are currently implemented in the HVE simulation environment. These are the Tire Slip algorithm and the HVE Bosch Version 1 algorithm. Tire Slip - This is a simple and straight-forward ABS algorithm. Its design is based on the fundamental goal of an ABS system, which is to maintain tire slip in the vicinity of peak friction coefficient. It is generally applicable to any type of vehicle (passenger car, truck, etc). HVE Bosch Version 1 Algorithm - The HVE Bosch Version 1 ABS algorithm is based on the information provided in Bosch technical literature. The algorithm is based on wheel spin acceleration and a critical tire slip threshold. The Bosch ABS system is used on many US and foreign passenger cars.

To further enhance the results from an ABS simulation, HVE now includes a new method for displaying tire marks. In the new method, the opacity of a tire mark is varied according to the current vertical tire load (heavier tire loads produce darker marks), the percentage of longitudinal tire slip and the percentage of lateral tire slip (increased slip produces darker marks). In addition, a set of weighting coefficients determines the opacity of tire marks during combined braking and steering. Since the vast majority of vehicles are now fitted with ABS, the new HVE ABS model is an important new feature, especially for simulating pre-impact braking and loss of control.

HVE Brake Designer *(Available to use in SIMON, EDVSM and EDVDS)*

The HVE Brake Designer is a time-domain simulation model of user-defined brake system components. The purpose of the HVE Brake Designer is to provide a detailed brake design capability integrated directly within the HVE simulation environment. Engineers can reduce costs by performing simulated compliance tests of complete vehicles on a digital proving ground prior to expensive prototyping and proving ground testing. Examples include steering and braking on high-friction, low-friction and split-mu surfaces at different speeds and loading conditions. In addition, alternative brake designs can quickly be evaluated.

The HVE Brake Designer model incorporates advanced features, such as the effect of sliding speed and temperature on lining friction. The model also includes the capability to study brake fade characteristics, such as that which occurs to trucks on long downhill grades. Parameters defining physical, performance and material properties of brake components are fully user-editable.

Values for brake factor, actuation factor and brake torque ratio are calculated by the HVE Brake Designer. Initial values are based on the environment's ambient temperature and zero sliding velocity at the pad/rotor (or drum/lining) interface. During a vehicle dynamic simulation, the appropriate brake factor and brake torque ratio are based on the current brake internal temperature and sliding velocity calculated by the simulation. Outputs from HVE-compatible vehicle dynamics simulation models using the HVE Brake Designer include brake torque, brake stroke, brake pressure, brake piston force, drum/rotor temperature and lining temperature.

DyMESH 3-D Collision Model *(Available to use in SIMON)*

DyMESH is a computer model for 3-D dynamic simulation of motor vehicle crashes. DyMESH employs methods from finite element technology for collision detection, and stress-strain relationships for force calculation. DyMESH uses a 3-D vehicle mesh with mechanical properties as input and produces vehicle-fixed collision forces and moments as output. The output from DyMESH is then used by the vehicle simulaton model along with suspension forces, aerodynamic forces and inter-vehicle connection forces to produce the total vehicle-fixed forces and moments acting on the vehicle at each timestep. Whereas a finite element analysis requires several hours (sometimes days), a simulation using DyMESH is complete in a few minutes. Results from DyMESH agree favorably with theory, test and finite element results.

DyMESH is useful for all collision simulations, and is especially useful for underride, or any crash where three-dimensional collision dynamics are present. All types of vehicles (passenger car, truck, trailer, dolly, barrier) may be involved in any number of simultaneous collisions. Using the HVE simulation environment, vehicle deformation is visualized as it is calculated during collision simulations. Researchers can compare simulated damage against actual damage from staged collisions or real world crashes as a means to validate their simulation results. Because the vehicle mesh typically includes several thousand nodes, HVE displays the resulting damage with great resolution.

HVE FEATURES AVAILABLE TO USE IN HVE-COMPATIBLE PROGRAMS (cont.)

HVE Driver Model *(Available to use in SIMON, EDVSM and EDVDS)*

The HVE Driver Model is a closed-loop driver model, allowing users to define an attempted maneuver and have the simulation determine the required steering inputs to make the vehicle follow the defined path. Typical examples include single and double lane-change maneuvers. The HVE Driver Model may also be used to study the effects of driver fatigue and intoxication.

The HVE Driver Model has four components: Path Generator, General Parameters, Driver Descriptors, Driver Neuro-Muscular Filter. The path generator uses up to eight 3-D positions and orientations to define the attempted path. The path is constructed from a 3-D spline curve passing through each user-specified location and tangent to the roll, pitch and yaw orientations for each location. The general parameters provide control over the Driver Model algorithm. Control parameters include driver starting time, driver sample interval, driver preview distance, allowable path error, and initial steering wheel angle. The driver descriptors describe how the operator attempts to control the vehicle. These parameters include the driver preview distance (the point ahead of the vehicle where the driver is actually looking and presumably wants to go), driver comfort level (lateral acceleration), maximum steering wheel velocity, steer correction rate and steer correction damping. The driver neuro-muscular filter represents a mathematical model of the human operator in man-machine performance. The model used in HVE was derived from the model described by McRuer, et al (1965) as published in the NASA Bioastronautics Databook (NASA SP-3006). The model includes an effective time delay representing the time required to read, interpret and decide upon the appropriate control motion, the lead time representing a ratio of the weight the driver attributes to the displayed velocity compared to the displayed position, and the time lag representing the amount of data smoothing the driver applies to his external stimuli. These parameters correspond to the first-order effects of the neurological and muscular systems of a human driver.

HVE Steer Degree of Freedom Model *(Available to use in SIMON and EDVSM)*

The HVE Steer Degree of Freedom Model allows users to study how hands-off steering affects vehicle trajectory. The steering linkage of the vehicle is assumed to be rigid, thus the angular acceleration about the steering axis is the same for right-side and left-side wheels. External steer forces are generated at the tire-road interface, thus producing a moment about each tire's steering axis according to the tire's pneumatic trail. The moments are resisted by steer system inertia and internal coulomb friction. Steering is limited by right and left steering stops at each wheel. Based upon these conditions, the steering inputs used in the simulation are calculated from the interaction of the vehicle's tires traveling over and interacting with the 3-D terrain model defined by the user. An obvious application of the Steer Degree of Freedom Model is the post-collision motion of a vehicle.

HVE Tire Blow-out Model *(Available to use in SIMON, EDVSM and EDSMAC4)*

The output from the HVE Tire Blow-out Model provides detailed information regarding the transient nature of a vehicle's response to a tire blow-out that occurs during any maneuver. Dynamic changes in tire forces and moments are calculated and displayed, giving researchers the capability to simulate and predict the outcome for one or more driving scenarios, and to study how these transient forces affect vehicle handling.

To study transient effects, the HVE Tire Blow-out Model operates in the time domain (i.e., the dependent parameters are varied according to time). By far, the greatest effect of reduced inflation is on cornering stiffness, camber stiffness, radial tire stiffness and rolling resistance. Therefore, these parameters were made the dependent parameters in the blow-out model. The dependent parameters are varied using linear interpolation, starting at the initiation time and lasting over the blow-out duration. The dependent parameters are multiplied (stiffness values) and divided (rolling resistance) by user-entered blow-out factors to create the blown tire properties.

For more information about HVE, contact EDC Customer Service or visit our website at www.edccorp.com. The website offers detailed product descriptions, tutorials, simulation movies, technical publications, newsletters and other helpful information available to directly download from the pages of the site.

ENGINEERING DYNAMICS CORPORATION • 8625 SW Cascade Ave, Suite 200 • Beaverton, OR 97008 USA
Phone 1.503.644.4500 • Fax 1.503.526.0905 • Email: info@edccorp.com • www.edccorp.com