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SIMULATION OF VEHICLE IMPACT WITH THE TEXAS CONCRETE MEDIAN BARRIER— TEST COMPARISONS AND PARAMETER STUDY

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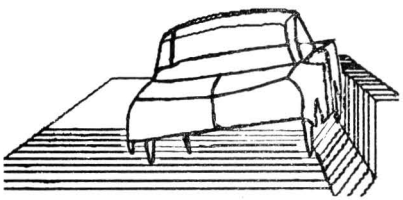

Comparison of Simulation and Test for Impacting the Texas CMB.

Cooperative Research Program of the
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Simulation of Vehicle Impact With the Texas Concrete Median Barrier—Test Comparisons and Parameter Study

by

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The concrete median barrier (CMB) is a wall separating opposing lanes of traffic. Its cross-section, which has been called the "safety shape," is generally patterned after the New Jersey and General Motors designs. Maintenance of the CMB is virtually nonexistent and tests have shown that vehicle impacts at low angles are not hazardous to the occupants. Therefore, this barrier is especially well suited for use in narrow medians of roadways carrying high traffic volume.

The objective of this study was to produce additional detailed information which would aid the highway designer in making decisions during the evaluation of an existing roadway for possible installation of the CMB and during the design of a new roadway for accommodating the CMB. The objective was met by using a mathematical computer simulation[1] to predict the response of a standard size automobile impacting the Texas CMB (New Jersey type) at specified speeds and impact angles.

The ability of the computer model to simulate a vehicle impacting the CMB was successfully demonstrated by numerically reconstructing three full-scale tests on the Texas CMB with a 4000-lb. car at 60 mph and impact angles of 7, 15, and 25 degrees.[2] After validation, the model was used to extrapolate the test results to encroachment conditions of 50, 70, and 80 mph and angles of 5, 10, and 15 degrees for each speed. The simulation results are summarized in Table 1.

In addition, the severity of each of the simulated CMB impacts (as computed from an index based on vehicle G-levels) was related to probable occupant injury as a function of encroachment conditions (Figure 1). For example, Figure 1 suggests that for a design speed of 70 mph, the roadway and median widths should be adjusted such that a vehicle could not be steered into the barrier to achieve an impact angle any greater than 10 degrees. Deleys[3] has suggested a method of estimating

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[1]A modified version of the HVOSM (Highway-Vehicle-Object Simulation Model).

[2]Hirsch, T. J., et al., "Vehicle Crash Test and Evaluation of Median Barriers for Texas Highways," Research Report 146-4, Texas Transportation Institute.

[3]Deleys, N. J., McHenry, R. R., "Highway Guardrails—A Review of Current Practice," NCHRP 36, 1967, p. 7.

TABLE 1. RESULTS OF CMB BARRIER SIMULATIONS

RUN NO.	AUTO WEIGHT	IMPACT CONDITIONS		AUTOMOBILE KINEMATICS				AVERAGE ACCELERATIONS DURING PRIMARY IMPACT			
	(LBS)	SPEED (MPH)	ANGLE, θ_1 (DEG)	MAX. ROLL (DEG)	MAX. PITCH (DEG)	FRONT TIRE CLIMB (IN)	EXIT ANGLE** θ_2 (DEG)	G_{LONG}	G_{LAT}	G_{VERT}	SEVERITY*** INDEX
1	4780	50.0	5.0	1.3	0.9	4.6	1.1	0.49	1.61	0.12	0.33
2	4780	70.0	5.0	2.2	1.5	6.5	0.3	0.72	2.53	0.43	0.52
3	4780	80.0	5.0	3.3	1.8	7.1	0.1	0.21	2.90	0.54	0.58
4	4780	50.0	10.0	4.2	3.2	8.6	2.5	1.13	2.99	0.94	0.64
5	4780	70.0	10.0	19.5*	5.0	11.2	1.2	0.16	5.06	2.03	1.07
6	4780	80.0	10.0	34.6*	5.8	12.6	1.2	1.92	6.42	2.61	1.38
7	4780	50.0	15.0	15.0*	6.5	11.9	3.6	0.47	4.29	1.38	0.91
8	4780	70.0	15.0	RO	6.6	NA		2.81	6.44	3.16	1.45
9	4780	80.0	15.0	RO	6.1	NA		3.24	7.49	3.29	1.66
10	4210	61.9	7.0	4.7	2.3	7.4	2.2	1.07	3.21	0.64	0.67
11	4210	59.6	15.0	21.0*	8.2	13.2	5.5	2.78	6.86	2.92	1.48
12	4000	63.0	25.0	37.0	8.6	NA	5.1	6.47	11.23	4.38	2.54

*Estimated roll obtained by energy expression using initial conditions from computer simulation at the time it was terminated.
**When vehicle loses contact with barrier.
***A severity index of 1.0 or greater implies that serious or fatal injuries are probable for unrestrained occupants.
RO = Rollover
NA = Not available

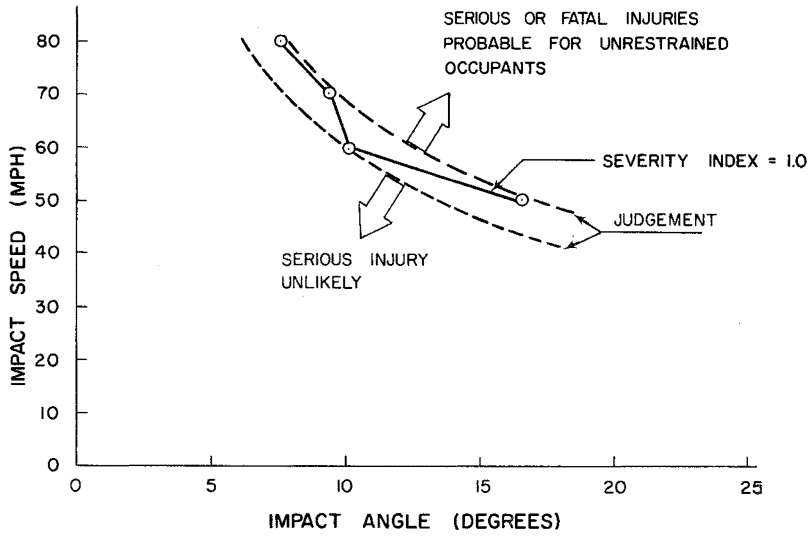

Figure 1. Relation between encroachment conditions at a severity index near unity for CMB.

impact angle as a function of lateral distance, speed, and tire-roadway friction. Such a method is needed to apply the information in Figure 1.

Other significant findings of the study were that: (1) vehicle rollover can be expected for speeds of 70 mph and greater at impact angles of 15 degrees and greater, (2) for speeds of 80 mph and less at impact angles of 15 degrees and less, the car exhibited no tendency to vault or climb the barrier, and (3) for the ten impact conditions simulated, where rollover did not occur, the car's exit angle after impact was shallow (less than 6 degrees).

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