This list of commands also contains some commands that are relevant for the integration constants and the starting and stopping time of the desired simulation, in which once again several combinations of integration parameters under their logical names can be called from the library.

The management of output data consists of several different "postprocessors" with which it is possible to produce tabular as well as graphical representations of important mechanical parameters (position, speed, accelerations of systems and subsystems). It is also possible to produce relatively simple three dimensional drawing of the simulated event. A visual review is made possible by this.

Besides that a special option is available with which all other parameters that are used in the simulation but not shown through a standard postprocessor, can be recorded; in that case one has to program one's own (simple) postprocessor to make the output accessible.

F. Verifications/Validations

It is difficult to validate completely such a multi purpose model with tests.

Until now validation has taken place using 12 full scale tests on roadside slopes and a number of test situations that have been found in the literature.

At the moment a validation of the pseudo-finite-element structure is being carried out using laboratory tests with vibrating beams and thin walled shells (Giavotto).

Although the different verifications have shown model deviations and in some cases model errors (that are for the most part already corrected) it can be stated that, in general, the model gives satisfactory results: the timing of the phenomena that are simulated are often within a 15% error margin, the magnitude often within 20%.

G. Applications

The VEDYAC model has already been used in many cases. Roadside slope research was one of them. A report about that study is being prepared. Furthermore, the model was used to simulate a train collision. More work in that area is expected later this year. Also research on concrete median barriers has been carried out. A report elaborating the difference between two important barrier types has been presented to our government.

The following paper will report about this research.

SHAPED CONCRETE BARRIERS RESEARCH USING THE VEDYAC MODEL, by Tom Heyer, Stichting Wettenschappeliuk Onderzoek Verkeersveiligheid, (SWOV), Netherlands

Introduction

About a year ago, a Dutch government agency consulted SWOV about the applicability to Dutch highways of two types of concrete barriers: the General Motors design and the New Jersey type. Since there was insufficient funding for extensive full scale tests, SWOV has based its advice upon a literature study and a quite large number of vehicle/barrier impact simulations with the model VEDYAC.

The first activity has been a study to calibrate the modelling results with the best documented tests found in the literature. To this end data sets of three different types of small cars have been assembled: the BMC Mini, the Honda Civic and, representing a majority of cars on the Dutch roads, the Opel Kadett. Furthermore a set of criteria for comparison of test conditions and test results had to be established; these were:

- test conditions: encroachment angles varying from five to 30 degrees (steps of five degrees) at speeds of 60, 80 and 100 km/h.
- test results: magnitude of maximum roll angle, maximum attained height of the front wheel first contacting the barrier and the ASI value (weighted (?) accelerations of the center of gravity of the car). The literature did not provide data for all possible combinations, and furthermore, calibration was made difficult by incomplete documentation of the full scale tests. It was, for instance, often unclear whether steering gear had been fixed in a "straight ahead" position or had been allowed to rotate freely during the testing. Also, the literature from different sources sometimes provided inconsistent results in similar tests; in all these cases the simulations had to "fill the gaps."

Summary of the Results of the Calibration Studies

The predictions of the model studies comply well with full scale test results as long as initial conditions are not severe; that is, if either the encroachment angle is less than 15 degrees or impact speed is lower than 80 Km/h. More severe conditions generally show deviations in one or more output parameters. The latter is probably caused by the increasing importance of unknown (and therefore estimated) parameters like inertial properties, deformation characteristics of parts of the body contacting the barrier, friction coefficients, shock absorber characteristics, steering conditions etc. and need not be inherent deficiencies of the model.

On this basis it was decided to continue the comparison of both barrier types with the current version of the model (to limit the response time toward the government) and also, to start a parameter sensitivity study to determine the cause of deviations; at this moment the latter study is not quite completed, but some interesting results and indications have already been obtained and will be reported here.

Results of the Comparison

The main difference between the two barriers appears to be the maximum attained height of the front wheel contacting the barrier. For this parameter the New Jersey barrier practically always produces lower, and therefore safer, values. This difference is more pronounced when the car is smaller. The parameters, maximum roll angle and ASI value, also show smaller differences but not consistently in favor of a single type of barrier. The ASI values are nearly always considerably higher than the accepted safety limit (ASI=1). Only infrequently did the vehicle rollover or mount the barrier, and only in severe cases. On the basis of these results, taking into account the uncertainty of modelling results under severe impact conditions, it was concluded that the New Jersey type barrier is better suited for Dutch conditions than the G.M. configuration.

Results of the Parameter Sensitivity Study (up to now)

There are a large number of parameters that affect the magnitude or direction of contact forces during a collision with a shaped concrete barrier. There are so many, in fact, that a preselection must be made to limit the number of tests. In the tests done so far, the following parameters have been investigated:

- moments of inertia around roll-, pitch- and yaw axes,
- position of the center of gravity of the car,
- characteristics of shock absorbers,
- moment of inertia of impacting wheels,
- shape of the lower part of the barrier,
- friction coefficient of barrier surfaces.

Summary of Results

- A variation of 10% plus and minus of the vehicle moments of inertia effected a change of about the same magnitude in yaw- and roll angles and the maximum height of the front wheel, and had virtually no effect on the pitch angle and ASI values.

- The position of the center of gravity, especially in the vertical direction, proved to be of great influence of the magnitude of the roll angle in the sense that a small increase in height tended to increase the rolling motion toward the barrier. Other parameters were not significantly affected. Sideways displacements also had some effect, but were less drastic.

- Introduction of very bad shock absorbers having 10% of their original damping coefficient, only affected the motion of the vehicle after contact with the barrier was broken, but had no significant effect on the roll mounting height and ASI values.

- An older version of the model VEDYAC did not take into account the inertia of the rotating wheels and showed only very moderate barrier "climbing" phenomena. After the introduction of more realistic inertial effects the vehicle "climbing" increased considerably.

- In addition to tests on the G.M. and New Jersey barrier types a number of tests have been conducted with the Configuration-F barrier. This barrier features a junction between the upper and lower sloping faces that is lower than the other two barrier types, while the New Jersey barrier has a lower junction height than the G.M. configuration. Comparison led to the (preliminary) conclusion that decreasing the height of the lower sloping face decreases the rolling motion of the impacting car and thus lowers the risk of overturn. The adverse effect of a lower sloping face is that the severe collision with the upper part of the barrier takes place sooner. Evidently, a tradeoff in the design is in order.

- The friction coefficient of the barrier surface also has considerable effect on the outcome of the impact, but mainly under less severe impact conditions; with severe conditions the results are not appreciably different.

To obtain a better reference to judge overall barrier performance, a number of tests were performed using a simple vertical faced concrete wall. As it turned out, the ASI values were only slightly worse in case of collisions with severe impact conditions, but there were no rollovers. Under more moderate impact conditions the sloping faced barriers were clearly superior since the vertical wall then continued to impart very high impact accelerations. As it is mainly the lower part of the barrier that is effective under moderate conditions, the combination of a shaped lower part and a vertical or even inwardly inclined upper part seems to gain respectability, since rollovers may be prevented and severity is not greatly increased.

Conclusions

The work on the sensitivity study is not yet completed, because a number of potentially influential parameters have not been investigated. Such parameters can be: slope and friction properties of the road surface adjacent to the barrier, deformation characteristics of the front end of the impacting cars, height of the curb on the lowest part of the barrier etc. Still, it appears that a number of influential factors already have been identified; they can and will be used in the effort to optimize the shape of the barriers. The work with the VEDYAC model can only be considered as preliminary; a model of this type always needs verification. Presently, a conglomerate of Italian road owners, united in SINA, is taking the initiative to carry out an extensive program of full scale tests. They envisage 80 tests, 60 of which will concern concrete barriers. These tests, to be carried out in close cooperation with the designers of VEDYAC, will have to be used for calibration of the VEDYAC model so that an even greater number of tests can be made with the aid of the model. Therefore, the tests will be conducted with great attention to the actual values of important parameters. Calibrating the model however is surely not the only objective of the tests; in the interest of optimal effectiveness and general applicability of results, all interested parties are invited to participate, especially in the planning stage of this project. Results will, of course, be open to the public and available at negligible cost.

MEDIAN BARRIER CRITERIA FOR ALL-PURPOSE DUAL CARRIAGEWAY ROADS - A FEASIBILITY STUDY

by G.R. Watts, Transport and Road Research Laboratory, Crowthorne, Berkshire, England

Abstract

Safety fences on motorway central reserves (median barriers in highway medians) have been accepted as necessary safety features since 1978. However on all-purpose dual carriageway roads where design standards vary it was not until 1981 that such barriers were generally accepted and then only on heavily trafficked new dual carriageways.

The paper describes the initial results from a study designed to develop installation criteria for such barriers. The overall objectives of the study were:

A. to identify road features and traffic flow parameters which contribute to the causation of cross-median accidents and to quantify their effects,