





4. Human resistance forces - Joint friction, braced and unbraced grip forces, hand on wheel.
5. Injury Limits - Bone breakage forces, internal injury force limits.

Defense Research Laboratories - (A. Rydquist, J. Anderson)

For the area of energy absorption, the Defense Research Laboratories are primarily involved in the investigation and development of experimental devices and materials, individually and in aggregates. Specifically, devices and materials under consideration are:

1. Water-filled bumper
2. ~~Inter-tube~~ *INTER-TUBE*
3. Polyurethanes
4. Honeycombs

As an aggregate, an arrangement using a water bumper and ~~inter-tube~~ *INTER-TUBE* assembly should adequately absorb energy for impacts below 10 mph. For impacts below 5 mph, the bumper dissipates energy without any permanent deformation; between 5 and 10 mph, the ~~inter-tubes~~ *inter-tubes* invert and must be replaced, but no other part of the car is damaged. An energy absorbing aggregate such as this, requires a much stiffer vehicle frame than is presently used.

An impact testing machine is scheduled for installation by the end of May, 1966. It will be capable of impacts at speeds up to 60 mph or loads up to 5000 lbs.

Mathematical models of energy absorbers are being formed. The model for the water bumper shows that there is considerable design freedom in choosing cross-sectional shapes and holes.

A permanently inflated instrument panel was considered as an energy absorber, but upon analysis, it appears that such an arrangement would store energy instead of dissipating it.

The Cornell occupant simulation computer program was used to evaluate complete restraint systems (lap and shoulder belts). Belt loads resulting from a 30 mph barrier collision may be reduced 30% by changing the front crush characteristic from the present production condition to a constant deceleration level. The advantage of the constant deceleration decreases with decreasing impact speeds; there is no advantage at 15 mph, and the constant deceleration gives higher belt loads at speeds below 15 mph. Belt loads may also be reduced 50% by allowing the anchorages to yield at about 1500 lbs.

Research Laboratories (D. Martin, J. Danforth)

Research Memorandum 34-1527 discusses the potential advantage of altering the vehicle structure to provide a constant deceleration crush characteristic instead of a linearly increasing deceleration characteristic. For a 30 mph barrier impact, an unrestrained or lap-belted occupant will experience a 4% reduction in head impact velocity with the constant level; a completely restrained occupant will experience a 25 to 30% reduction in belt load. The study failed to indicate realistic conditions under which constant deceleration would be disadvantageous to the striking car. However, severe intrusions will be imposed on the car <sup>SIDE</sup> ~~front~~ <sup>STEEL</sup> ~~structure~~ ~~on the side~~ by a car whose front end has been stiffened for constant deceleration, unless ~~the side of the struck car has also been stiffened~~. As a result, current engineering knowledge does not justify an immediate and radical redesign of the vehicle. The tailoring of exterior crush characteristics should be approached cautiously and should begin with the side structure.

The Wayne State University impact sled facility has been used to verify the Cornell computer program using cadavers.

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Crush characteristics of instrument panel elements have been evaluated by dropping a headform on the panel. A thin covering of soft padding was found to increase possible injuries by enlarging the area of contact and thereby requiring a larger total force to deform the panel.

Work is being continued to extend the range of validity for calculation of injury numbers beyond the present 2 to 50 millisecond pulse duration. An injury number program is now available on the GE-265 time-sharing computer ~~(GADDON++)~~ ~~(GADDON++)~~ ~~(GADDON++)~~

Direct digitizing of acceleration-time curves is available using the DAC facility, FORTRAN. Programs using this digitized information are now being written.

Proving Ground - (R. Wilson)

An analog computer study has been made to determine how to best protect the occupant in side impacts, assuming that there is no penetration into the target car. Within reasonable size limitations, peak occupant accelerations may be reduced only 15% by utilizing external crush. Greater gains may be realized with a stiff exterior and a padded interior. Interior padding should be stiffer than necessary to insure that it does not bottom out. Padding which is too soft effectively increases the distance of the occupant from the door and allows him to gain a higher relative velocity before contacting the solid surface.

The Proving Ground has also been working with the Cornell occupant simulation program. An energy absorbing steering column has been included, and work is presently proceeding on improving the model of the man and adding a model for a steering wheel.

The modified Cornell program has been used to study the effects of various types of front crush characteristics. For a totally restrained passenger, a constant vehicle deceleration was found to be the best. The cases involving an unrestrained or lap-belted passenger are more involved, however. With present interior geometry and front structure, the car is stopped

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P. C. Skeels

Perhaps an instrument panel is needed which would be soft for light impacts but which would become stiff for higher velocity impacts.

C. W. Gadd

If the instrument panel were to be positioned nearer to the passenger, it would be possible to take advantage of the additional collapse distance available. In addition, the knees can take impact.

L. C. Lundstrom

Knee contact tends to force the body upward. On the other hand, considerable deflection in the contacting surface could force the body downward while absorbing energy.

J. R. [unclear]

No great breakthrough on front structure is seen for 1969.

O. K. Kelley

Fisher Body is presently working on side door strength.

R. A. Wilson

Door padding appears important, and work is presently being done in this area.

O. K. Kelley

It was the consensus of opinion of the group that met in the morning that more communication is needed among the people working on energy absorption. Consequently, it was decided that it would be a good idea to have meetings continued at six-week intervals.

A fixed front seat may not be ready for 1969. Instrument panel structure will be improved.

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Report No. PG-2173

L. C. Lundstrom

~~We are presently in trouble with the "A" or PILLAR~~

~~Now~~ Perhaps it should have a steep slope

so that any impact would result in a glancing blow.

Moving it out of reach of a belted occupant would

also be helpful.

V. D. Valade

The importance of complete restraint must be emphasized

to the public. There is definite room for improvement

in shoulder belt configurations in terms of convenience.

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