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Consumers Union's Dynamic Tests of Seat Belts

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On the off-chance that some of you may not be completely familiar with Consumers Union, we shall first take a few moments to explain our general purposes and methods.

Consumers Union is a non-profit, non-commercial testing organization serving the individual's need for unbiased factual information about the products he buys and other problems which affect him as a consumer. The consumer's need for such information has its roots in the river of biased and confusing information to which the gentle art of advertising exposes him every day. It is our function to guide him to the best products, or to the best which he can afford, by testing the available products to the extent that our resources permit. To do this with an absolute minimum of bias, we avoid any possibility of obligation to the manufacturers—for example, we do not accept samples from manufacturers, buying them from retail outlets instead. We consult the technical men in industry for their opinions of the various test methods available, but we must form our own independent conclusions as to which test methods serve the needs of the consumer best. In this way we avoid any bias for or against any manufacturer, and our test methods are as unbiased as we can possibly make them. But it is important for us to maintain one bias—we favor the consumer's interests. These considerations guide us whether we are testing refrigerators or raisins, automobiles or aspirins, soap or seat belts.

The October issue of CONSUMER REPORTS will contain our third report on seat belts, and we hope it will serve as a timely guide for the many purchasers of 1962 cars which will be equipped with built-in attachment hardware, and for all other car owners as well. Our previous reports on tests of seat belts were published in May 1956 and in February 1960.

The Product Has Improved

The 1960 tests showed that seat belts were stronger than they had been in 1956; there was a decided improvement in quality during the intervening years, as manufacturers learned how to make better belts, to wit:

In 1956 CU reported that less than 60% of the belt assemblies it tested withstood a 3,000-pound loop test load, but in 1960 95% passed a 3,000-pound test, 67% passed a 4,000-pound test, and 33% withstood a 5,000-pound test.

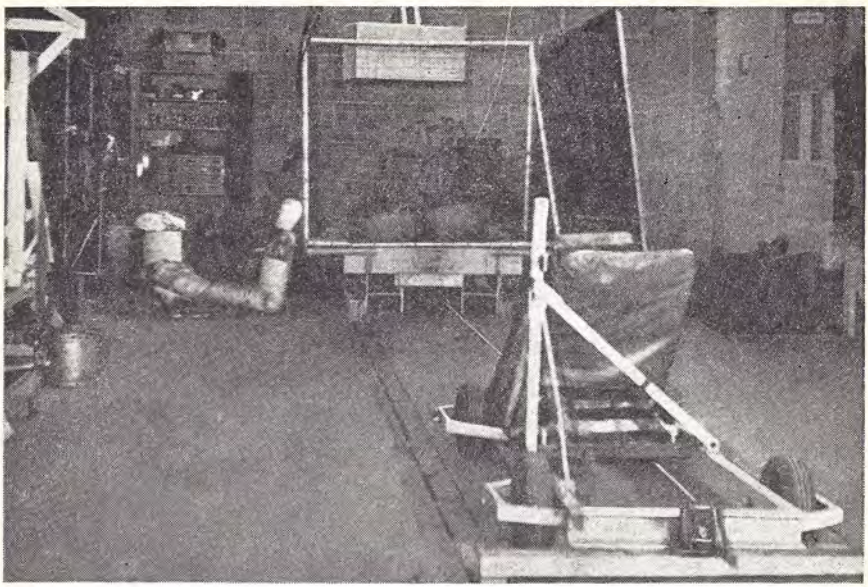

Fig. 1

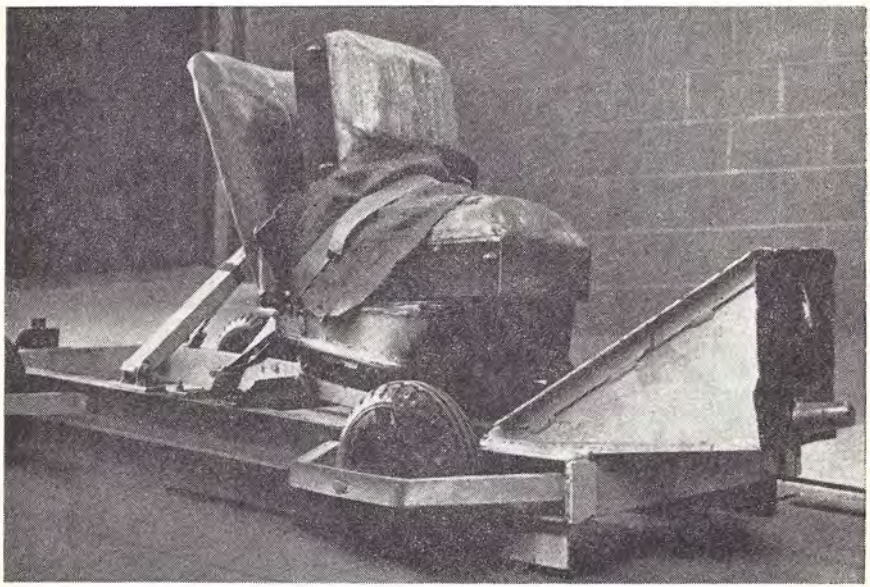

Fig. 2

The Standards Have Increased Their Requirements

In keeping with this trend, the Society of Automotive Engineers (S.A.E.) increases the strength requirement of its "recommended practice" from time to time. In 1955 it recommended that belt assemblies should withstand a load of 3,000 pounds; in 1958 it raised this to 4,000, and it is now considering raising it to 5,000 pounds. The federal specification (for government-purchased belts) has required a 5,000-pound test load since 1958.

This brief history of test requirements for seat belts has been cited to show that such standards are arbitrary, not absolute. They reflect the "state of the art" rather than any academic ideal; as better seat belts become available, the standards become more stringent. And each of the previous times that CU tested seat belts, we were guided by the highest standard available at that time.

CU's Test Method Also Improved

The standards mentioned above (S.A.E. and government) both specify a similar test method for the seat belt assembly—a slow application of test load. This "static" test method was used by CU in its first two tests. In actual accidents, however, the belts are subjected to very rapidly applied loads. Under such conditions things may happen to the belts which do not happen when the load is applied slowly, as Dr. Finch of U.C.L.A. indicated in his SAE report entitled "Dynamic Testing of Seat Belts" in 1956. Since CU prefers tests which subject the product to conditions which approximate actual use as closely as possible, we changed our test method this year to a dynamic method which simulates actual crashes. Our move in this direction received encouragement from our hosts at this conference, Colonel Stapp and Professor Ryan, and from many others who are present at this conference. The machines with which such tests can be made in this country were not available to CU, and so arrangements were made with the Swedish government to have CU's belt samples tested at their National Institute for Materials Testing in Stockholm, which has such a machine. (See Figures 1 and 2).

The Swedish government uses this machine to test auto safety harnesses which are sold in Sweden. The Swedish specification requires the harness to withstand a 25-mile per hour crash, with a stopping distance of roughly 3½ inches. A 150-pound dummy is used with flexible joints at the waist and neck; these joints are held together by heavy chains and springs mounted internally.

The "car" is made of structural steel beams welded together, on which is mounted, also by welding, an automobile seat. The car is put into motion by a falling one-ton weight which accelerates the car to any desired speed by suitable alteration in the height of fall of the weight.

The belt is attached to the "floor" of the vehicle (and to the "center door post" when a harness requires it) in accordance with manufacturers' instructions. It is then drawn up snugly around the dummy. The car, with a lead

cone screwed in place on its front bumper, is pulled forward to a concrete pier, and crashes against a steel plate on the concrete pier. The lead cone, the only part of the car which strikes the barrier, is deformed under the force of the impact; the work used in deforming the lead cone absorbs the kinetic energy of the car, and stops it within a few inches without any damage to the car or the concrete pier.

In our preliminary trials with American lap belts, in which the Swedish test conditions were used, that is, the 25-mph speed and the flexible dummy, it became apparent (1) that American-made lap belts would not withstand the forces involved (at least in part because there are fewer straps holding the body), and (2) that the Swedish dummy would not be able to survive all the crashes required for CU's extensive tests (well over 200 crashes were used). Therefore, for the tests on CU's samples both the dummy and the speed were modified. A non-flexible dummy was constructed of steel, wood, and sponge rubber, and the test speed was decreased.

The "dummy" used in the tests on CU's samples weighed 150 pounds, and was really a cross between a full-scale dummy (that is, a complete body including head, arms and legs) and a "body block" such as is used in most tests in the U.S. The body block used in the SAE and the GSA static test methods is a half-cylinder of eight inches radius, about five inches in length, and of unspecified weight. In the California State Highway Patrol dynamic test, it is a similar half-cylinder, but is filled with lead to bring its weight to 150 pounds. Like these various body blocks, CU's "dummy," which is shaped to represent an average body's torso and thighs, has a pelvic area whose cross-section is a half-cylinder of eight-inch radius. The half-cylinder's axis is at about 45-degrees from the vertical, so that the lap belt lies flat upon the pelvic area when the belt is mounted at a 45-degree angle, as recommended by the SAE. Like the American body blocks, the CU dummy has a medium-density sponge-rubber covering on this pelvic area.

The speeds used in CU's tests were 21, 18, 15, and 12 mph. The tests simulate very severe crash conditions in that the car's stopping distance is only a few inches. Such a crash at low speed develops as much deceleration as a crash at a much higher speed in which the car takes the more usual several feet to stop. Therefore the speeds used in the tests cannot be viewed as the highest speed crashes which the various belts will withstand in the more common accident situations—far from it. Both the speed *and* the stopping distance determine the deceleration forces operating in a given accident, so that each crash test speed used by CU may be considered to represent a continuum of various accident conditions, all of them severe. For example, a crash at 21 miles per hour stopping in three inches produces roughly the same deceleration forces on the car as a crash at 42 miles per hour stopping in one foot, or a crash at 63 miles per hour stopping in 2¼ feet.

Testing the belts at four different speeds enabled CU to rank the belts on a comparative basis—those which withstood the most severe crash condi-

tion are ranked highest in our ratings, while those which withstood less severe crash conditions are ranked below them. Each belt was classified into one of the four main groups established on the basis of the crash speeds each model could withstand. (In order for a belt to qualify for a particular group, at least two samples were required to survive the crash tests at the speed which defined that group, without any sign of incipient failure, and with no failures of other samples at that or at any lower speed. Only one failure at a given speed was deemed sufficient to disqualify a model from the group defined by that speed. Three to nine samples were needed to establish the relative performance of each seat belt model.)

This system of classifying belts is a departure from the practice employed in the S.A.E. and the government standards, and also by CU in its previous reports, of considering a belt simply as either acceptable or non-acceptable. In effect, we have now differentiated the belts which are acceptable into three quality groups: (1) those which passed the most severe crash test used without any sign of incipient failure, and which therefore can be considered the very best of the belts tested; (2) those which survived the next lower speed crash test without any sign of incipient failure; and (3) those which survived the arbitrary minimum standard (in this case, a crash of 15 miles per hour under the test conditions used).

Only those which did not pass the 15-mile per hour test were rated Not Acceptable. This was an arbitrary cut-off point, but no more arbitrary than the 3,000, 4,000, or 5,000 pound minimum acceptable loads of the SAE and the GSA, or the 20 G deceleration of the vehicle in the California State Highway Patrol test. Actually, almost any belt will give some degree of protection, even if it should break in the course of an accident. Because of this, and with its knowledge that belt strengths have increased generally, CU adopted a cut-off point which rated most of the belts Acceptable. We did this in order to encourage consumers to buy belts, even if they could not obtain the very best. The buying of a particular brand and model of belt is not usually easy, but our new ratings make it possible for virtually all motorists to find acceptable belts without too much hunting, and without having to settle for belts in the lowest quality group in order to get any belts at all.

Forty-two of the 52 belts tested were rated Acceptable, of which seven were check-rated for having passed the 21-mph test, 26 were listed as next best, and nine were listed as having passed the minimum acceptable speed test. Only 10 belts were rated as Not Acceptable.

The Nature of the Belt Failures

The major points of failure of the belts tested were the webbing (usually at the buckle or at the floor brackets) and the floor brackets themselves. In a few cases the buckles broke. Somewhat unexpected was the failure of the stitching in some belts; in most cases where this occurred it was the stitching

just above the floor hooks, not that near the buckle. Most belts have no stitching at the floor fastening end; they are usually threaded through the floor bracket. But some of those with "sister hooks" have a stitched loop at that end. In all cases where we tested two belts which were identical except that one had sister hooks and a stitched loop and the other did not, the one with sister hooks failed at a lower speed because the stitching of the loop around the sister hook failed to hold. It seems clear that more attention must be paid to the geometry of the stitching at that point, particularly if the use of such sister hooks is to become more common.

The Forces Involved in These Tests

I regret to say that we have not yet had the opportunity to complete our work on this test method—we have not yet measured the decelerations of the car and the dummy or the loads on the belts in these crash tests. We hope to do this in the near future, and will make this information available as soon as we obtain it.

What we have accomplished so far is a ranking of seat belts by a more realistic method than we had used previously, to provide buying guidance for the consumer. As I said earlier, this is our main interest.

Belts vs. Harnesses

The one serious design flaw in most seat belts on the American market is that they are only lap belts. In Sweden, as mentioned earlier, such belts are not used because they do not restrain the upper torso and head. They permit a body to jackknife, and the head can easily strike the dashboard or other parts of the car interior, particularly in small cars or cars with dashboards which protrude considerably into the passenger compartment. The Swedish harnesses are usually a combination of lap and diagonal chest straps, with two anchors on the floor, a third on the center door post. For example, the Swedish car *Volvo* comes equipped with such a harness. And the British Motor Corporation has just announced that all its new cars will come equipped with anchors for such harnesses. (One American-made harness whose chest strap was anchored in the floor behind the seat, was tested by CU; it barely passed the minimum acceptable standard used by CU in this series of tests.)

Since the American public is apparently not ready to accept harnesses at this time, it is obviously desirable to have a combination of lap belts, recessed and well-padded dashboards, and other energy-absorbing devices, plus an absence of sharp corners and protruding knobs. The improvement and standardization of these designs would go a long way toward compensating for the shortcomings of the present American-style seat belt.