Air Bag Progress Report 8
The Fatal Flaw in the Air Bag Theory

We consider again the dummy test scenario, i.e., a car smashing perpendicularly into a concrete wall at 30 mph with a foot of crush. How far removed this is from real automobile accidents we have already seen in our previous reports (l,2,3,4, etc.). This time, however, instead of going by a seatbelt dummy test video, we go by an air bag dummy test video (5). It appears from the video that the bag has fully deployed before the dummy hits it, that the dummy falls forward about six inches before hitting the bag and that the bag is about 12 inches thick at that point. This too is unlikely to happen in a real accident for a large number of reasons, including ignition delay, off design conditions, and other factors which we shall discuss in later report. Notice that the seatbelt appears to be holding the dummy back until the air bag has fully deployed. (All of these crash test videos are faked one way or another).

As we have already seen in a previous report (6), using actual air bag deployment data, the occupant in that case is struck by the bag while it is still deploying, causing him serious injury or death. The purpose of this report, however, is to show that even if all the fallacious assumptions of the air bag theory are fulfilled, the air bag is still not going to save the driver.

Taking our data from figure 1 and the table from our previous report (6), when the occupant has moved six inches the time is 32 ms after impact and the crush is 0.912 feet, so the vehicle has only about an inch left to go before it stops.

$$x = a\frac{t^2}{2} + V_1 t = 0.912$$

when t=.032 seconds. The vehicle occupant, however, has roughly 13 inches left to go, 12 inches relative to the vehicle and one inch with the vehicle. In other words, he is still decelerating from 44 fps to zero in about a foot, as in the seatbelt case (7), assuming the air bag is compressed or deflates to the steering wheel under the impact of the vehicle occupant. Since the car will have stopped after .045 seconds (6), i.e., .013 seconds after the driver hits the bag, the force on the driver would be higher if the bag stops him sooner since he would stop in a shorter distance. So we are considering the most favorable condition. The only difference the air bag can make is to change the rate of deceleration of the driver. Given the constraints, can the bag decrease the maximum force on the driver?

Let a’ be the deceleration for the case of constant deceleration and let ε be a function of t such that

$$\frac{d^2x}{dt^2} = a' + \varepsilon$$

Then
$$\frac{dx}{dt} = \int a'\,dt + \int \varepsilon\,dt + c_1$$

$$\frac{dx}{dt} = a't + \int \varepsilon dt + c_1$$
$$x = a'\frac{t^2}{2} + t\int \varepsilon dt + c_1 t + c_2$$

The boundary condition are at x=0, t=0, V=V_1 ; at x=x_1, V=0 and t = t_2 Therefore, c_1=V_1 and c_2 = 0.

Let t_{21} be the time required to for the driver to come to a stop in the case where ε = 0. Then $a' = -\frac{V_1}{t_{21}}$ **and**

$$x = -\frac{V_1}{t_{21}}\frac{t^2}{2} + t\int \varepsilon dt + V_1 t$$

and $$V = a't + \int \varepsilon dt + V_1$$

At t=t_2 V=0, and hence $0 = -\frac{V_1}{2}\frac{t_2}{t_{21}} + \int_0^{t_2} \varepsilon dt + V_1$ **Now let** $R = \frac{t_2}{t_{21}}$

Then $$\int_0^{t_2} \varepsilon dt = V_1(R-1)$$

and $$x_1 = -\frac{V_1}{2}t_{21}R^2 + t_2 V_1(R-1) + V_1 t_2$$

Now $x = \frac{V_1}{2}t_{21}$ **hence** $\frac{V_1}{2}t_{21} = -\frac{V_1}{2}t_{21}\left[-R^2 + 2R(R-1) + 2R\right]$

It follows that R^2 =1 and, therefore, $\int_0^{t_2} \varepsilon dt = V_1(R-1) = 0$

Thus it is not necessary for ε to be zero, only for the average value of ε to be zero over the time of deceleration. This means that if the air bag lowers the rate of deceleration initially, it must increase subsequently or the driver will not come to a stop at the requisite point in the requisite time. Thus the minimum maximum rate of deceleration will occur when the rate of deceleration is constant. Since the distance in which the driver comes to a stop has not been substantially changed by the air bag, the force on the driver will be substantially the same as in Puzzle 1 (7), i.e., around 4,500 pounds.

References:

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