12.4 Speeds from Scrapes and Gouges

Drag factors for sliding motorcycles have been published that range from 0.2 g for a bike with full crash bars to 1.0 g for a bike with a foot peg or a pedal cutting a deep furrow in a soft surface, like deep gravel or soft earth. The 0.2 g sounds suspiciously low and might be for a bike that still has one or more rolling wheels carrying weight. I once watched a bike slide away from me more than 50 feet even though it had been going less than 20 miles per hour. It was on two wheels and one crash bar. The road was so oil-soaked that I had to crawl to the shoulder before I could stand up.

The 1.0 g drag factor mentioned was for a dragged bike that might have tumbled or reoriented if left to itself. This illustrates where engineering judgment becomes so crucial. Did the bike leave furrows, gouges, or scrapes? How deep? In what? Continuous or intermittent? Did it stay down and slide, bounce, tumble or high-side? Did the bike right itself and roll on its tires (they really can)? How far did the bike travel as it fell over, before it really achieved a slide mode? Did it slide on plastic parts, steel, aluminum or rubber? It could be highly desirable to test slide a similar bike on a comparable surface if possible.

The most comprehensive listing of suitable drag factors is available from SAE paper number 970963. It takes some experience however to determine which test best approximated the accident conditions.

12.5 Speed from Flight

The "proper" drag factor for objects (particularly bodies) that depart from the bike and fly, then slide to rest, is a controversy among reconstructionists. Some argue for drag factor during the slide as high as 1.1 g and others as low as 0.4 g. If we drag a volunteer a short distance on paving we get a friction coefficient close to 0.4. When we measure dynamic friction coefficient for cloth samples, we get between 0.4 and 0.65.

Proponents of the higher limit argue that as the body tumbles along the ground, the drag is higher than sliding. Physics dictates, however, that a body will follow the path of least resistance. Why would it then tumble if this increases the resistance?

One "analysis" is based on the following logic. If an ejected body travels a certain distance airborne, lands, then slides, no velocity is lost while airborne, therefore the deceleration distance is the slide distance alone. Therefore, in a staged 30-mph example, the body "flies" 29 feet then slides 20 feet. Then drag factor is calculated to be

$$v^2 / (2 \times g \times 20),$$

or 1.2 g. This is defined as the average deceleration during sliding. In the real world, of course, you will probably not know the impact point.

The flaw in this logic is that, at the landing point, the vertical force is not the weight, it is the weight times the impact acceleration (measured in g's). The landing may dissipate more energy than the slide. If, on the other hand, we calculate the average deceleration for the entire distance, we get drag factor = 0.55 g. If we apply the vault formula to the entire distance:

$$\text{speed} = \frac{3.87 \times \text{distance}}{\sqrt{\text{distance} - \text{height}}}$$

$$\text{speed} = \frac{3.87 \times 50}{\sqrt{50 - (-3)}} = 26.6 \text{ mph}$$

If we use the speed-from-skid formula:

$$\text{speed} = \sqrt{30 \times \text{drag factor} \times \text{distance}} \text{ (in miles per hour)}$$

for the entire distance with drag factor of 0.5 g we get s = 27.4 mph. Reasonably close. If we use drag factor of 1.2 g we would get s = 42 mph, 59 percent too high.

When a pedestrian is hit by a car that is skidding, the point of rest of the pedestrian is almost always in front of the car, unless he goes over the car. Typically the pedestrian pendulates onto the hood, then slides off in front of the car. If the pedestrian had higher friction than the car, he would then be run over, but, as long as the car is skidding, he never is. Therefore, it is a fairly safe assumption to use a drag factor of 0.5 g for the entire ballistic path from launch to rest.

There is some empirical data developed in tests involving rear-end impact of nearly stationary motorcycles by cars. Both body and bike travel distances from impact to rest varied substantially from test to test, such that the drag factor varied from 0.22 g to 0.83 g, although above 25 mph the minimum increased to 0.35 g. It makes one very suspicious of the data-gathering process; obviously the trajectories were quite varied. Assuming a drag factor of 0.5 g would be the safest singular assumption; one can also calculate the two extremes.