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Bicycle Crash Reconstruction

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Bicycle Crash Reconstruction involves the application of scientific and engineering principles to determine how the incident started and what initiated the loss of control. Vehicle speeds and positions at various times and distances are investigated, as well as the location of vehicles at impact.

Collision avoidance maneuvers (if any) are also reconstructed. It is determined whether vehicle and road conditions were deficient in a manner that was a cause of the crash or a cause of the resulting injuries. Operator actions, as well as environmental factors, are also evaluated to determine if they were causes of the collision.

Consistent with the National Highway and Traffic Safety Administration (NHTSA) and the National Safety Council, the term "crash" is preferred to "accident," because accident implies inevitability and most collisions are not inevitable.

Three recent investigations involved bicyclists who crashed and received brain injuries. One issue to resolve was, "Did a nearby road defect cause the fall?" In all three cases, the cyclists did not know what happened. There was a witness present in only one case to link the fall to the defect. In the other two cases, the cyclist was not wearing a helmet and a second issue became, "Would brain injury have occurred if a helmet had been worn?"

The roadway defect was either a pothole or an excavated trench that had not been restored flush with the surrounding pavement.

A bicyclist can fall for many reasons: something goes wrong with the bicycle, the cyclist hits something in the road or he encounters a pedestrian, another bicycle or a motor vehicle.

Techniques employed to determine if the fall is linked to the defect include examining the bicycle for damage and ruling out a mechanical problem. Vehicle contact must be ruled out by inspecting the bicycle for vehicle contact damage. Time

records can also show limited exposure of the cyclist to other vehicles. Witness testimony can rule out the possibility of other bicyclists or pedestrians. Scene photographs and similar analyses can also determine if roadway defects are linked to the fall.

An analysis can be performed to determine if the cyclist had been ejected at the defect, would he have traveled to his observed point of rest, for reasonably obtainable speeds? This analysis uses trajectory mechanics, similar to a bullet or any object that is launched, to determine the speed a cyclist would have to travel to reach the observed distance. This distance is often called the "throw distance," which is the distance from the defect to the cyclist's point of rest. The horizontal distance traveled can be related to the speed of the bicycle at the defect and the time for the cyclist to have traveled the throw distance. The time is related to the height the cyclist fell from and the acceleration of gravity. Thus, with just the throw distance, it is possible to determine the cyclist's speed at the point of defect.

The throw distance can be determined from roadway evidence such as bloodstains or where the police locate the cyclist on a diagram. Received injuries are used to approximate the angle at which the cyclist was ejected; e.g., back of head and shoulder injuries indicate a steep angle of fall and, therefore, a steep launch angle; facial and other body part scrapes indicate a shallow angle. Reasonably obtainable speeds are determined by bicycle testing at the site.

If the calculated speed is within the range of speeds that can be reasonably obtained at the site and, if there is no other cause, then we can conclude that the nearby road defect did cause the fall.

The second question is: "Would brain injury have occurred if a helmet had been worn?" No helmet can protect against all possible impacts and the impact may exceed the helmet's protection. No helmet protects any part of the body that it does not cover. Additionally, the impact may be so severe that the helmet fails or your brain may move inside your skull so much that you have a brain injury.

This question is answered through crash reconstruction and biomechanics. The potential for brain injury depends on the force that was applied to the head. The force is related to how fast the head was decelerated and the amount of the body that was decelerated with the head; e.g., a whipping action would involve only the weight of the head, while a head-on pile driver type fall would involve more of the body.

Bicycle crash reconstruction is used to determine how the head was impacted and the forces to which the head was exposed. The helmet contains a liner that compresses upon impact. This compression increases the time over which the head is decelerated and thus reduces the applied force.

Brain injury can occur with and without skull fracture, but with skull fracture there is always injury to the brain. The calculated forces with the helmet (our theoretical case) are then compared with injury tolerance criteria for skull fracture to determine if brain injury would have occurred even with a helmet.

Vehicle speeds and positions at various times and distances are investigated, as well as the location of vehicles at impact.