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Vehicle coordinate systems

For a moving vehicle, there are several coordinate systems that need to be defined in order to be able to analyze the motion of the vehicle under the influence of forces acting on it. Ultimately, when imposing Newton's Second Law, the vehicle's motion in a fixed coordinate system is what is important. This system is fixed to the earth, so it is given the subscript "E". The vertical axis is Z_E and points upward out of the earth. Often the X_E axis points north, but it can be oriented in any direction that's convenient. Often X_E is selected to be in the original direction of motion of one of the vehicles or in the direction of one of the roadway's where the accident occurs. If X_E is oriented north, then Y_E points west in a right-handed coordinate system.

The vehicular coordinate system X_V-Y_V-Z_V is fixed to the vehicle at the center of mass. X_V is longitudinal and points toward the front of the vehicle. Z_V points upward so is parallel with Z_E. Y_V is the transverse axis and points to the left of the vehicle.

Figure 1 shows these two systems in a plan view. Also shown is the velocity vector of the vehicle. In this case the vehicle is obviously sliding, since the velocity vector is pointed off in an arbitrary, oblique direction. There are three angles that are important. ψ is often referred to as the *yaw angle*. But yaw, referred to a ship or an airplane, is the difference between the way the vessel is aimed compared with the way it is travelling. In a ship or airplane, ψ is referred to as the *heading angle*. In the nautical and aeronautical world, β is then the yaw angle, and it will be referred to as such in these articles.
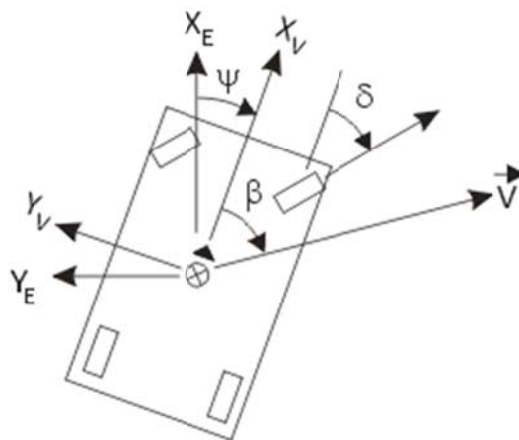

Figure 1 – Vehicular coordinate systems

One other important angle is δ, the steering angle. This is the angle that the wheels are turned *relative to the vehicle.* So, if the wheels point straight ahead, δ is 0.

There are other coordinate systems useful in accident reconstruction. These will be described later as needed.