In the thesis, we derive the well-known equation of geodesic deviation, and then by relaxing one of the initial assumptions we obtain its generalized form. Next, we rewrite the generalized equation in an invariant form projecting the Riemann tensor onto an orthonormal frame associated with the fiducial observer moving along the geodesic in D-dimensional spacetime. We decompose the Riemann tensor into the traceless Weyl tensor, Ricci tensor, and scalar curvature and express these quantities with respect to the null frame. In general, the projections of the Weyl tensor enable us to study the spacetime properties based on its algebraic type. Finally, we employ the Einstein field equations to relate the Ricci tensor and scalar curvature, respectively, with the matter content of the spacetime. As an explicit example, we discuss the Kundt spacetime of algebraic type II representing gravitational waves propagating on the type D background in D-dimensional Einstein's gravity.