As a type of shock-capturing scheme, the traditional Roe scheme fails in large eddy simulation (LES) because it cannot reproduce important turbulent characteristics, such as the famous $k^{-5/3}$ spectral law, as a consequence of the large numerical dissipation. In this work, the Roe scheme is divided into five parts, namely, ξ, δU_p, δp_p, δU_u, and δp_u, which denote basic upwind dissipation, pressure difference-driven modification of interface fluxes, pressure difference-driven modification of pressure, velocity difference-driven modification of interface fluxes, and velocity difference-driven modification of pressure, respectively. Then, the role of each part in the LES of homogeneous decaying turbulence with a low Mach number is investigated. Results show that the parts δU_u, δp_p, and δU_p have little effect on LES. Such minimal effect is integral to computational stability, especially for δU_p. The large numerical dissipation is due to ξ and δp_u, each of which features a larger dissipation than the sub-grid scale model. On the basis of these conditions, an improved all-speed Roe scheme for LES is proposed. This scheme can provide satisfactory LES results even for coarse grid resolutions with usually adopted second-order reconstructions for the finite volume method.