Significant damage has been observed due to the landslide along the East–West motorway section, located near Ain Bouzian–El-Harrouch region, Northeast Algeria. In this paper, a probabilistic study was carried out to assess the stability of a slope, with a total height of 60 m and varying inclination angles. Two cases were considered with and without the presence of the groundwater table. To investigate the failure probability of the slope, the collocation-based stochastic response surface method was employed. The input random parameters were the Young modulus E, cohesion C, and friction angle φ, where probabilistic system response is the factor of safety. To identify the effective contribution of each random parameter in the variability of the system response, a global sensitivity analysis based on Sobol indices was conducted. Also, a parametric study was realized to inspect the effect of input geotechnical parameter variations on the reliability of slope stability. The result showed that the slope reliability analysis is strongly influenced by the inherent variability of friction angle and hydrogeological ground conditions.