In this study, the split Hopkinson pressure bar testing method was used to quantify the dynamic strength characteristics of rocks with short cylindrical specimens. Seventy dynamic compression tests were conducted on 10 different carbonate rocks with the split Hopkinson pressure bar apparatus. Experimental procedure for testing dynamic compressive strength and elastic behaviour of rock material at high strain rate loading is presented in the paper. Pulse-shaper technique was adopted to obtain dynamic stress equilibrium at the ends of the sample and to provide nearly a constant strain rate during the dynamic loading. In addition to dynamic tests, the physical properties covering bulk density, effective porosity, P-wave velocity and Schmidt hardness of rocks, and mechanical properties such as quasi-static compressive strength and tensile strength were determined through standard testing methods. Multiple linear regression analyses were carried out to investigate the variation of dynamic compressive strength depending on physical and mechanical properties of rocks and loading rate. A three parameter model was found to be simple and provided the best surface fit to data. It was found that dynamic compressive strength of rocks increases with increase in loading rate and/or increase in rock property values except porosity. Statistical tests of regression results showed that quasi-static compressive strength and Schmidt hardness are most significant rock properties to adequately predict the dynamic compressive strength value among the other properties. However, P-wave velocity, quasi-static tensile strength of rocks could also be used to estimate the dynamic compressive strength value of rocks, as well, except the bulk density and effective porosity.