In this paper, a three-dimensional filter-matrix lattice Boltzmann (FMLB) model based on large eddy simulation (LES) was verified for simulating wall-bounded turbulent flows. The Vreman subgrid-scale model was employed in the present FMLB–LES framework, which had been proved to be capable of predicting turbulent near-wall region accurately. The fully developed turbulent channel flows were performed at a friction Reynolds number Re_τ of 180. The turbulence statistics computed from the present FMLB–LES simulations, including mean stream velocity profile, Reynolds stress profile and root-mean-square velocity fluctuations greed well with the LES results of multiple-relaxation-time (MRT) LB model, and some discrepancies in comparison with those direct numerical simulation (DNS) data of Kim et al. was also observed due to the relatively low grid resolution. Moreover, to investigate the influence of grid resolution on the present LES simulation, a DNS simulation on a finer gird was also implemented by present FMLB–D3Q19 model. Comparisons of detailed computed various turbulence statistics with available benchmark data of DNS showed quite well agreement.