Koyna region is well known for its triggered seismic activities since December 10, 1967 earthquake. Understanding shallow distribution of resistivity pattern in such seismically active area is vital for mapping fault, fractures and lineaments. However, inferring true resistivity distribution from the apparent resistivity data does not provide precise information due to inherent non-linearity in the data structures. Here we developed a new technique based on the Bayesian neural network (BNN) theory using the concept of Hybrid Monte Carlo (HMC)/ Markov Chain Monte Carlo (MCMC) simulation scheme. The new method is applied to invert Direct Current (DC) vertical electrical sounding (VES) data collected over the Koyna region, India. Prior to applying the method on actual resistivity data, the new method was tested for simulating synthetic signal. During optimization each trajectory is updated by approximating the Hamiltonian differential equations through a leapfrog discretization scheme. The stability of the new inversion method is tested in presence of correlated red noise and uncertainty of the results is estimated using the Bayesian code. The estimated true resistivity distribution is compared with the results of singular value decomposition (SVD)–based conventional resistivity inversion results. Comparative results based on the HMC-based Bayesian Neural Network are in good agreement with the existing model results, however in some cases, it also provides more detail and precise results, which appears to be justified with local geological and structural details. The new promising and faster BNN approach is quite useful for the interpretation of fractures and lineaments in seismically active region.