A novel three-dimensional (3D) lumped circuit-based metamaterial topology to model a 2D fishnet structure is proposed. The rotated transmission-line matrix (RTLM) unit cell, obtained as one independent half cell from the typical TLM unit cell by rotating the polarisations on each TLM unit port by 45°, saves computation time and decreases the cost in processing data when a structure is analysed, especially when some specific components of the structure are processed. Here, an RTLM unit cell is used to construct the lumped circuit of a fishnet structure. The dispersion characteristics of the lumped fishnet circuit are obtained and used to analyse the eigenmode and the propagation coefficient and Bloch impedance are investigated to explain the frequency characteristics. At the frequency region considered, the same left-handed frequency behaviour of the lumped fishnet circuit is achieved by the proposed compact fishnet RTLM model, agreeing well with the simulation results.