This paper describes a systematic calibration process of a Vissim model, based on data derived from BT detectors. It also provides instructions how to calibrate and validate a highway network model based upon a case study and establishes an example for practitioners that are interested in designing highway networks with micro simulation tools. Within this case study, a 94.5% proper calibration to all segments was achieved. First, an overview of the systematic calibration approach that will be followed is presented. A description of the given datasets follows. Finally, model's systematic calibration and validation based on BT data from segments under free flow conditions is thoroughly explained. The delivered calibrated Vissim model acts as a test bed, which in combination with other analysis tools can be used for potential future exploitation regarding transportation related purposes.