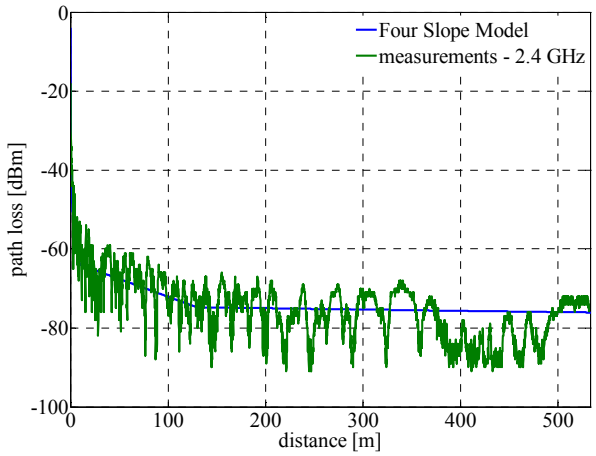

Fig. 9. Comparison of measurement results and path loss model for tunnel; f= 2.4 GHz

The validity of the four slope model is evaluated by measurements at 868 MHz and 2.4 GHz. In particular, the model is valued for the first three propagation regions while the tunnel length prevents the validation of the fourth part. Therefore, also the communication range of the individual systems essential for the network deployment is determined only theoretically. The measurements confirms present of the waveguide effect which occurs on certain distance from the transmitter and significantly extends communication range. Some disagreement between measurements and the model are also results of the tunnel shape and rough wall structures causing signal scattering.

IV. CONCLUSION

Radio channel characterization is an essential issue in design and deployment of any wireless communication systems. We analyze two wireless propagation channels suitable for wireless sensor networks, which at least for our opinion are appearing in smart city applications where the sensor nodes and sensor network gateways can be mounted on light poles due to permanent source of electrical energy. It was found out that the plane earth model perfectly model plane areas, and the four slope model can be applied for tunnels and street corridors for all three frequency bands suitable for wireless sensor nodes interconnection, namely, 400 MHz, 868 MHz and 2400 MHz. The model coefficients strongly depend on particular environment.

The proposed channel models can be extended also for street with vegetation, which may at least for high frequencies attenuate the signal significantly. Also the path loss dependence on transmitter and receiver height will be studied in future.

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