Chapter 4

CONCLUSIONS

Artificial neural network was applied for interpreting seismic refraction data of two-layer earth models with horizontal, dipping, and irregular interface in present study.

The designed networks comprised non-separated network and separated network. The non-separated network was designed for estimating seismic velocities in top and bottom ground layer and depth to interface. The separated network was composed of velocity network and depth network. The outputs of velocity networks were the seismic velocities in each ground layer and the outputs of depth network were depths to interface.

Two-layer and three-layer architecture were employed in both non-separated and separated network. Sets of training data for horizontal and dipping interface were synthesized from two-layer earth model, whereas those for irregular interface were taken from real field data records.

In addition, training and testing data sets were normalized before feeding them to train and test designed network. This was carried out in order to train a network to handle all cases of data set. The minimum-maximum normalization was chosen for the normalization technique in this research.

For horizontal interface the ground parameters were estimated only from non-separated network. The network was trained and tested by normalization and non-normalization data sets. The ground parameters estimated from the network was very good. The mean error and standard deviation of error of parameters estimated from a trained network were less than 5 % and 10 % respectively. Large errors of estimated depth at 1-m target with estimated top layer velocity of 500 m/s and 550 m/s target and estimated bottom layer velocity of 400 m/s and 600 m/s targets were observed. These errors were probably resulted from small difference between top and bottom layer velocity. The accuracy and precision of estimated velocities and depth from network trained with normalization and non-normalization data sets were not significantly different. The time spending for training a network with non-normalization data was shorter than that trained with normalization data. In case of network trained with non-normalization data set, the training time spending for two-layer architecture network was less than that for three-layer architecture network.

Among dipping interface network, both non-separated and separated networks were trained by normalization data sets. The mean error and standard deviation of error of predicted depth for all trained networks were less than 5 % and 10 % respectively, which was a very good result. It could be observed that testing data, which was normalized with normalization parameters of training data set, would give estimated velocity more accurate than testing data normalized with its own normalization parameters. The mean error and standard deviation of error of testing data sets for 10 m depth earth model were less than 5 % and 10 % respectively for top layer velocity and were less than 5 % and 20 % respectively for bottom layer velocity. For the testing data sets of 15 m interface depth earth model, the normalization parameters of testing parameters gave estimated velocities more accurate than other normalization parameters. The mean error and standard deviation of error for top layer velocity were less than 15 % and 10 % respectively and for bottom layer velocity were less than 5 % and 20 % respectively. The estimated ground parameters by non-separated and separated networks were not significantly different. The results obtained from t_{minus}-t_{plus} inputs and travel time inputs were also not significantly different.

For the irregular interface earth model, the depth network and velocity network were designed. The mean error and standard deviation of error of estimated depths, excluding shallower depth interface testing data, were less than 6.5 % and 21.5 % respectively. The mean error and standard deviation of error of estimated velocity, without shallower depth interface testing data, were less than 10 % and 20 % respectively. The number of training data might be responsible for the low accuracy of 2-m interface depth testing data set. The accuracy of estimated top layer velocity was less than that of estimated bottom layer velocity. It could be resulted from longer segment of refracted wave than that of direct wave. The 72-12-24 network was considered to be the most suitable network for estimating depth and velocity of irregular interface earth model.

The present results showed that it was possible to apply artificial neural network in interpretation of seismic refraction data. Raw data of travel time and geophone positions can be applied directly to designed network. Either two-layer or three-layer network architecture can be designed and trained for non-separated network or separated network, in determining ground parameters, since it yielded similar accuracy. In order to determine ground parameter with good accuracy, training data sets and testing data sets should be collected from the same geological area of study with large number of training data sets.