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Prediction of ultimate bearing capacity of Tubular T-joint under fire using artificial neural networks

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Abstract

An artificial neural network (ANN) model is developed for the prediction of the ultimate bearing capacity of tubular T-joint under fire. The input parameters of the network are composed of the diameter ratio (β), the wall thickness ratio (τ), the diameter – thickness ratio (γ) and the temperature (T). The output parameter is composed of the ultimate bearing capacity. In this paper, the training and testing data of the neural network are obtained using the finite element program ABAQUS. The network is trained by 216 dataset and tested by 27 dataset. In the process of training of the network, the Levenberg-Marquardt back-propagation algorithm is adopted. The ' tansig ' function is adopted in the hidden layer, and the ' purelin ' function is adopted in the output layer. The results predicted by ANN are compared with the results simulated by finite element method (FEM). These results show that the prediction of the ultimate bearing capacity using the network model is accurate and effective.

Highlights

► The back-propagation neural network is developed for predicting the limiting temperature of the tubular T-joints under fire. ► The weight matrices corresponding to the ANN model are obtained. ► The range of the relative error of the BP network is from 0 to 0.1405. ► The correlation coefficient between the simulation outputs and the expected outputs is 0.99848.

Keywords

Ultimate bearing capacity; Tubular T-joint; Artificial neural network; Finite element analysis; Fire

Figures and tables from this article:

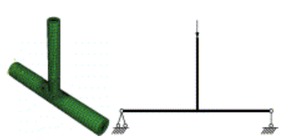

Fig. 1. Model and boundary conditions of finite element analysis.

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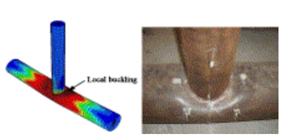

Fig. 2. Comparison of failure mode of the tubular T-joint (experiment and FEM).

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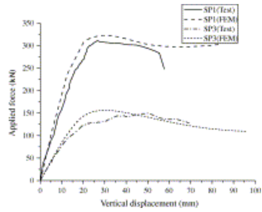

Fig. 3. Comparison of vertical displacement-ultimate bearing capacity of the tubular T-joint (experiment and FEM).

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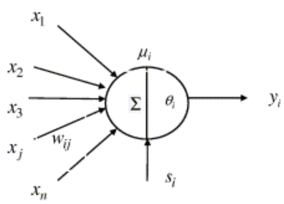

Fig. 4. Simple artificial neural model.

Figure options


Fig. 5. Back propagation neural network.

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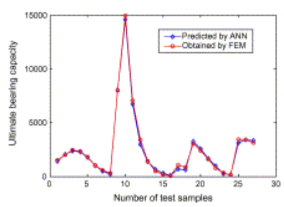

Fig. 6. Comparison of UBC predicted by FEM and ANN.

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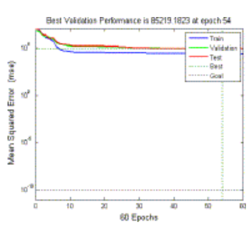

Fig. 7. The change of the error performance of the BP network.

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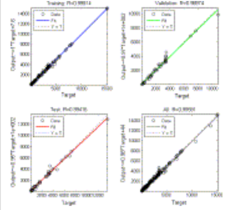

Fig. 8. The data regression situation of the BP network.

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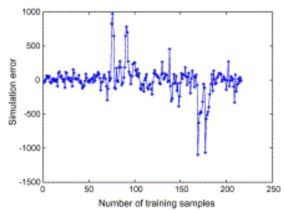

Fig. 9. The simulation error of the BP network.

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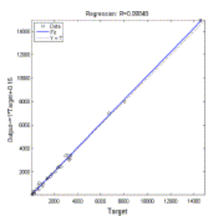

Fig. 10. The result of linear regressive analysis.

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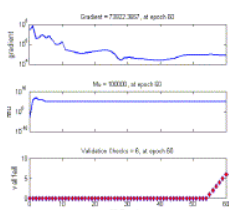

Fig. 11. The training process of BP network.

Figure options

Table 1. Finite element analysis models of tubular T-joints with different parameters.

Note: SPC denotes pressure branch pipe.

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Table 2. All of the input and output samples of the tubular T-joints.

Note: SPC denotes pressure branch pipe.

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Table 3. The validating and test samples of the BP network.

Note: SPC denotes pressure branch pipe.

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Table 4. Comparison of numerical test results for BP ANN.

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