Study of Monitoring Works Using Artificial Neural Network

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Abstract - As a giant and complicated project, the construction of Shibaozhai Breakwater in Chongqing needs subtle prediction of its stability and reliability. Such work is with great difficulty. However, by using artificial neural network under the MATLAB,we use the measured dataset to model the stability and reliability of the Breakwater project thus to forecast the index concerned.

Index Terms - Artificial neural network; MATLAB; Breakwater; Application Research.

1. Introduction

With huge investment , the construction of Chongqing Shibaozhai Breakwater project matters the security of Shibaozhai. Therefore it significant to anticipate its stability and reliability with precision. The measured data are collected in the process of construction by BGK steel stress meter and Inclinometer. With rapid development of artificial neural network theory, its application in structure reliability analysis gradually attains great focus. Artificial neural network is a nonlinear system made up of enormous processing units, which enjoys lots of advantages like: flexible adaptability , self- organization , quick learning ability , fault-tolerance, and anti-disturbance ability. It also can create efficient model directly based on sampled data[1] by avoid the complicated mechanism of an unknown system.

However, the realization of the network model needs high proficiency of the programmer and researcher, which ,to some extent, hinders the coverage and promotion of artificial neural network. To solve this problem, the use of MATLAB neural network toolkit is introduced to saves certain programming and debugging time. Thus the research can be concentrated on the modeling of the urgent problem, with great improvement in efficiency.[2]

2. Basic Principal And Procedure

The following are the analyses of measured data. We preprocess on the original data, use command premnmx(p) normalize data p (-1,1), then set up initial network, and train the network with data. Here we adopted Levenberg- M arquardt Algorithm, because it is very fast for the middle scale BP neural network, and Convergence error is small. Other network parameter set as: net.trainparam.epochs=2000 ; net.trainparam.goal=0.001 ; net.trainparam.show=20 ; net.trainparam.lr=0.6 ; net.trainparam.mc=0.6. Finally we use well-trained neural network, according to the time series, to proceed 20 times Monte Carlo simulation, and anticipate the future 5 steps[3].

TABLE 1 horizontal displacement of the first Random selected sectional observation

Date \ elevation (m)	136.7	138.2	142.2	147.7	151.7	153.2
2006-9-4	0.00	0.01	0.00	0.00	0.00	0.00
2006-9-10	0.55	0.68	0.18	0.16	0.36	0.10
2006-9-18	0.62	0.73	0.75	0.23	0.43	0.23
2006-9-23	0.77	0.61	0.60	0.36	0.10	0.00
2006-9-27	0.70	0.70	0.40	0.43	0.18	0.18
2006-10-2	0.64	0.91	0.45	0.48	0.33	0.30
2006-10-7	0.67	0.90	0.53	0.43	0.16	0.38
2006-10-12	0.57	1.03	1.00	0.38	0.36	0.35
2006-10-16	0.32	0.93	0.65	0.28	0.63	0.40
2006-11-5	0.67	-0.27	-3.90	0.73	0.38	1.75
2007-8-8	0.20	0.03	-0.12	0.78	1.23	1.28
2007-8-21	0.57	0.26	0.00	0.86	1.55	1.28
2007-9-8	0.42	0.06	-0.17	0.58	1.26	1.15
2007-9-17	-1.38	-2.12	-2.75	-1.97	-1.77	-1.85
2007-9-24	0.64	0.33	-0.05	1.08	1.55	1.40
2007-10-3	0.37	-0.15	-0.13	0.83	1.40	1.30
2007-10-11	0.04	-0.20	0.28	0.23	0.88	0.83
2008-3-2	0.17	-0.02	-1.35	0.68	1.23	2.90
2008-3-5	0.02	-0.22	-1.10	0.63	1.03	2.70

1. Elevation 136.7m

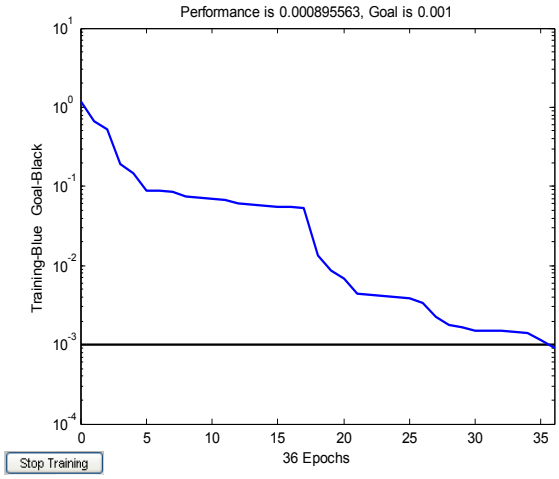

Fig. 1 training steps and performance

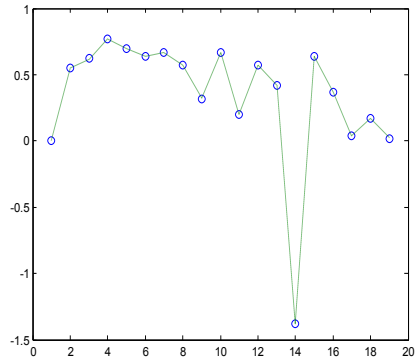

Fig. 2 horizontal displacement data(Dotted line) prediction data(mark with circles)

TABLE 2 The error of the prediction result analysis

Date	Actual data	Prediction data	absolute errors
2007-8-8	0.20	0.2048	0.0048
2007-8-21	0.57	0.5691	-0.0009
2007-9-8	0.42	0.4242	0.0042
2007-9-17	-1.38	-1.3728	0.0072
2007-9-24	0.64	0.6302	-0.0098
2007-10-3	0.37	0.3763	0.0063
2007-10-11	0.04	0.0284	-0.0116
2008-3-2	0.17	0.1688	-0.0012
2008-3-5	0.02	0.0338	0.0138

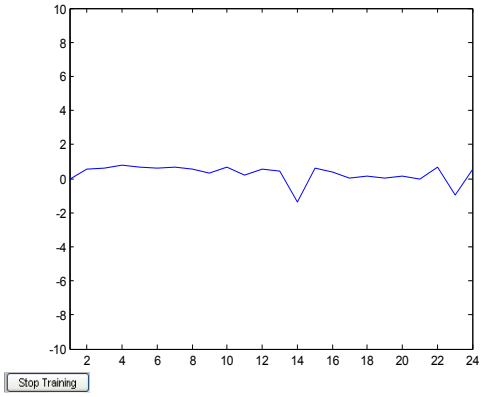

Fig.3 Elevation 136.7m measured data and 5 steps prediction curve

2.Elevation138.2m

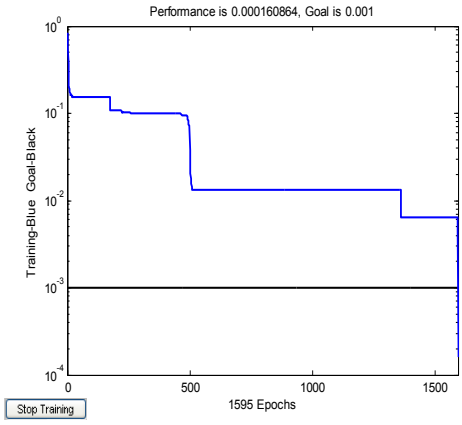

Fig.4 training steps and performance

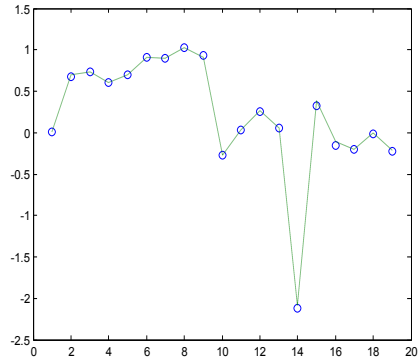

Fig.5 horizontal displacement data(Dotted line) prediction data(mark with circles)

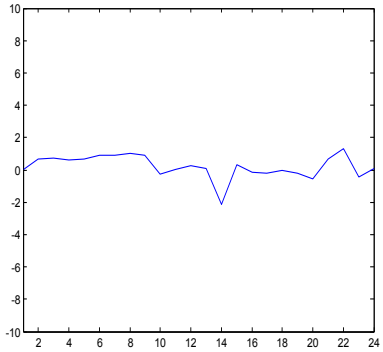

Fig.6 Elevation 138.2m measured data and 5 steps prediction curve

TABLE 3 The error of the prediction result analysis

Date	Actual data	Prediction data	Absolute errors
2007-8-8	0.03	0.0286	-0.0014
2007-8-21	0.26	0.2635	0.0035
2007-9-8	0.06	0.0547	-0.0053
2007-9-17	-2.12	-2.1160	0.0040
2007-9-24	0.33	0.3238	-0.0062
2007-10-3	-0.15	-0.1092	0.0408
2007-10-11	-0.20	-0.1790	0.0210
2008-3-2	-0.02	0.0008	0.0208
2008-3-5	-0.22	-0.1593	0.0607

3.Elevation142.2m：

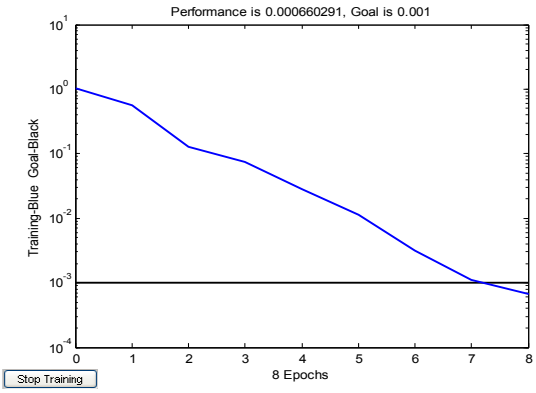

Fig.7 training steps and performance

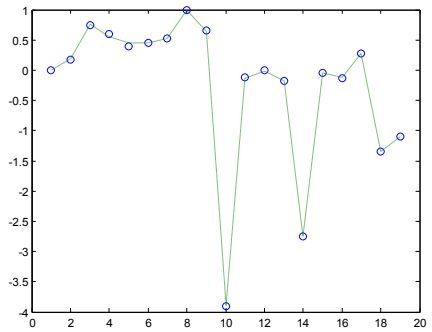

Fig.8 horizontal displacement data(Dotted line) prediction data(mark with circles)

TABLE 4 The error of the prediction result analysis

Date	Actual data	prediction data	absolute errors
2007-8-8	-0.12	-0.1249	-0.0049
2007-8-21	0.00	-0.0041	-0.0041
2007-9-8	-0.17	-0.1633	0.0067
2007-9-17	-2.75	-2.7493	0.0007
2007-9-24	-0.05	-0.0546	-0.0046
2007-10-3	-0.13	-0.1473	-0.0173
2007-10-11	0.28	0.2724	-0.0076
2008-3-2	-1.35	-1.3469	0.0031
2008-3-5	-1.10	-1.0961	0.0039

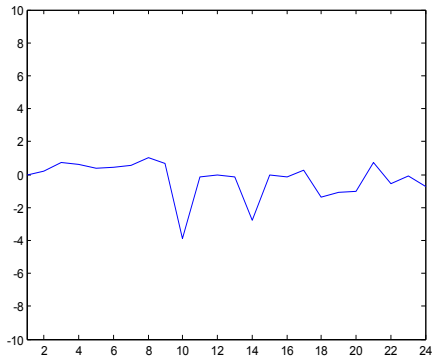

Fig.9 Elevation142.2m measured data and 5 steps prediction curve

4.Elevation147.7m：

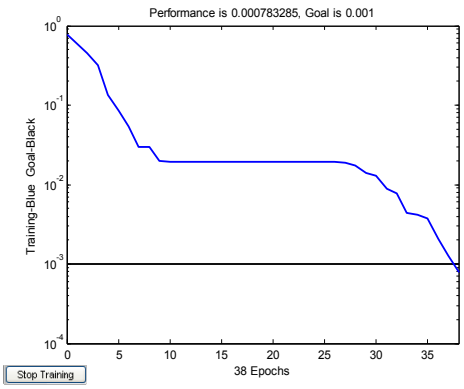

Fig.10 training steps and performance

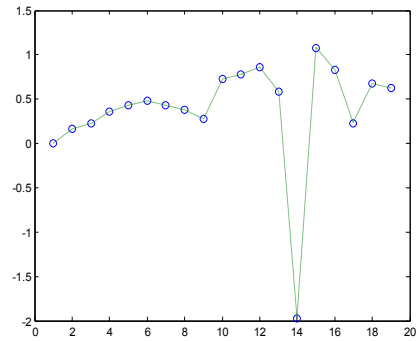

Fig.11 horizontal displacement data(Dotted line) prediction data(mark with circles)

TABLE 5 The error of the prediction result analysis

Date	Actual data	prediction data	absolute errors
2007-8-8	0.78	0.7794	-0.0006
2007-8-21	0.86	0.8597	-0.0003
2007-9-8	0.58	0.5796	-0.0004
2007-9-17	-1.97	-1.9718	-0.0018
2007-9-24	1.08	1.0747	-0.0053
2007-10-3	0.83	0.8327	0.0027
2007-10-11	0.23	0.2348	0.0048
2008-3-2	0.68	0.6763	-0.0037
2008-3-5	0.63	0.6268	-0.0032

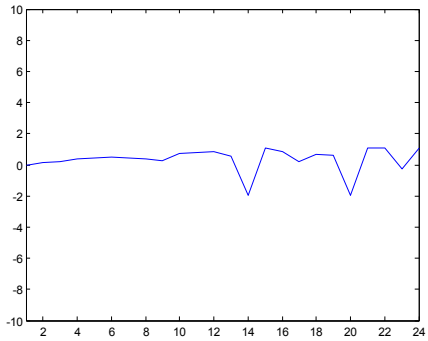

Fig.12 Elevation147.7m measured data and 5 steps prediction curve

5.Elevation151.7m：

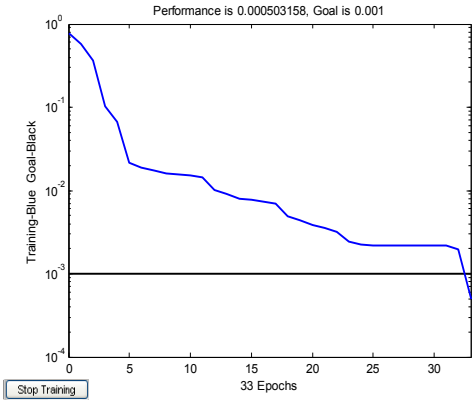

Fig.13 training steps and performance

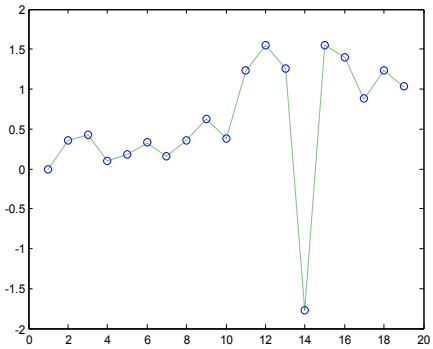

Fig.14 horizontal displacement data(Dotted line) prediction data(mark with circles)

TABLE 6 The error of the prediction result analysis

Date	Actual data	prediction data	absolute errors
2007-8-8	1.23	1.2304	0.0004
2007-8-21	1.55	1.5484	-0.0016
2007-9-8	1.26	1.2592	-0.0008
2007-9-17	-1.77	-1.7655	0.0045
2007-9-24	1.55	1.5543	0.0043
2007-10-3	1.40	1.3986	-0.0014
2007-10-11	0.88	0.8814	0.0014
2008-3-2	1.23	1.2288	-0.0012
2008-3-5	1.03	1.0256	-0.0044

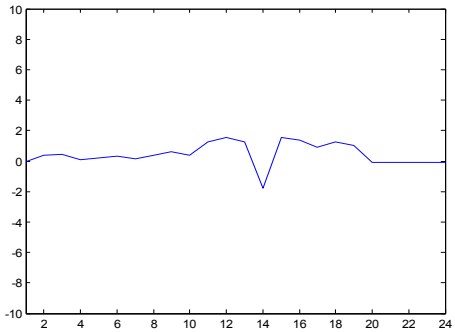

Fig.15 Elevation 151.7m measured data and 5 steps prediction curve

6. Elevation153.2 m：

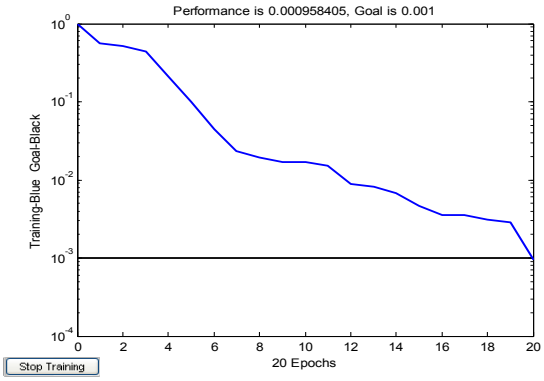

Fig.16 training steps and performance

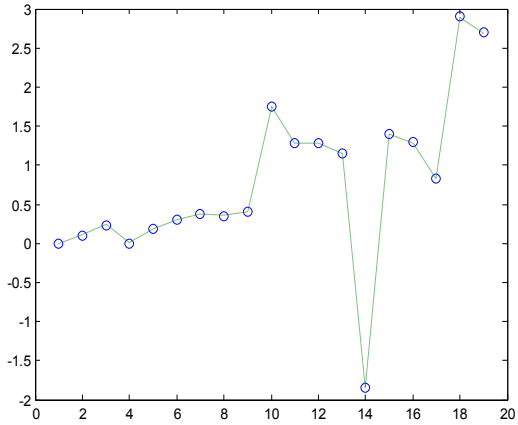

Fig.17 horizontal displacement data(Dotted line) prediction data(mark with circles)

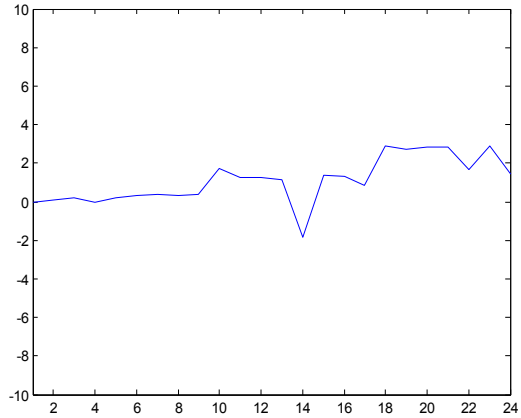

Fig.18 Elevation 153.2m measured data and 5 steps prediction curve

TABLE 7 The error of the prediction result analysis

Date	Actual data	prediction data	absolute errors
2007-8-8	1.28	1.2804	0.0004
2007-8-21	1.28	1.2830	0.003
2007-9-8	1.15	1.1537	0.0037
2007-9-17	-1.85	-1.8490	0.001
2007-9-24	1.40	1.4014	0.0014
2007-10-3	1.30	1.2860	-0.014
2007-10-11	0.83	0.8312	0.0012
2008-3-2	2.90	2.8898	-0.0102
2008-3-5	2.70	2.6833	-0.0167

Third section in different hole depth of measured Horizontal displacement value:

TABLE 8 Random selected Third section Horizontal displacement data(mm)

Date \ Elevation (m)	137.8	139.3	141.3	142.8	144.3	146.3
2006-7-2	0.00	0.00	0.00	0.00	0.00	0.00
2006-9-4	-0.10	1.17	0.05	0.18	-0.45	-0.77
2006-9-10	-0.34	1.27	-0.15	-0.02	-0.80	-0.65
2006-9-18	-0.54	1.15	-0.27	-0.02	-0.85	-0.75
2006-9-23	-0.47	1.19	-0.09	-0.15	-0.95	-0.10
2006-9-27	-0.17	1.22	-0.25	-0.02	-1.00	-0.88
2006-10-2	-0.44	0.92	-0.52	-0.15	-1.02	-0.90
2006-10-7	-0.35	0.97	-0.62	-0.13	-1.32	-0.77
2006-10-12	-0.69	1.42	-0.52	-0.12	-0.90	-0.65
2006-10-16	-0.52	1.72	-0.22	-0.05	-1.05	-0.55
2006-11-5	-0.57	1.52	-0.27	-0.10	-1.10	-0.65
2007-8-3	0.16	-3.46	0.63	0.40	0.30	-2.93
2007-8-13	-0.90	3.37	-3.37	-0.92	-3.43	1.20
2007-8-24	0.35	-2.63	1.18	0.88	1.05	-2.10
2007-8-31	0.08	-2.78	0.76	0.48	0.60	-2.43
2007-9-10	-1.44	-2.70	0.91	0.80	0.88	-1.97
2007-9-19	0.78	-2.23	1.43	1.30	1.45	-1.30
2007-9-28	1.28	-1.93	1.73	1.40	1.55	-1.50
2007-10-5	0.55	-2.23	1.10	0.78	0.68	-2.18
2007-10-13	0.43	-2.18	0.98	0.55	0.60	-2.20
2008-3-2	-0.07	-2.48	1.03	0.45	0.80	-3.20
2008-3-5	-0.02	-2.63	0.73	0.45	0.50	-3.25

1.Elevation137.8m：

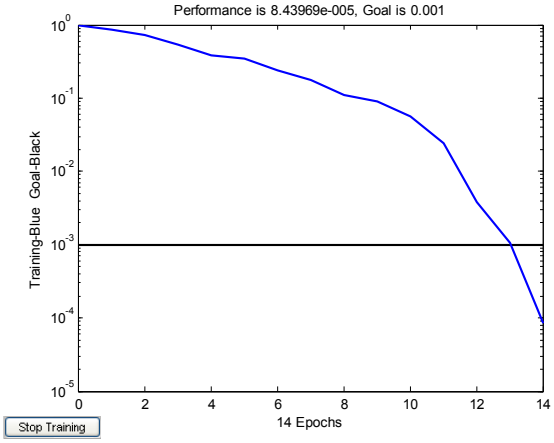

Fig.19 training steps and performance

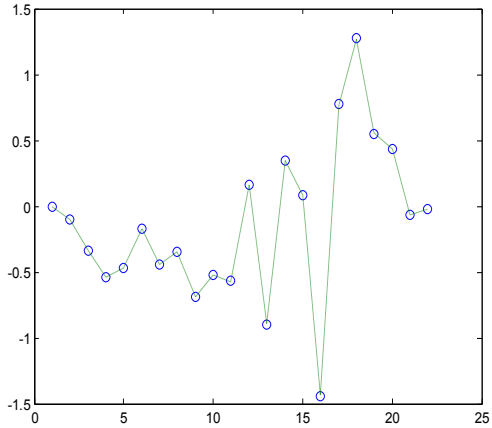

Fig.20 horizontal displacement data(Dotted line) prediction data(mark with circles)

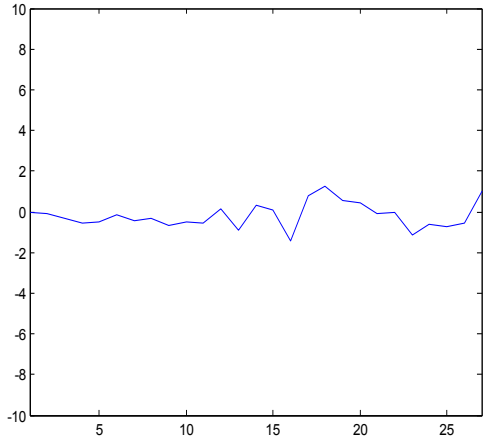

Fig.21 Elevation 137.8m measured data and 5 steps prediction curve

2. Elevation 139.3m：

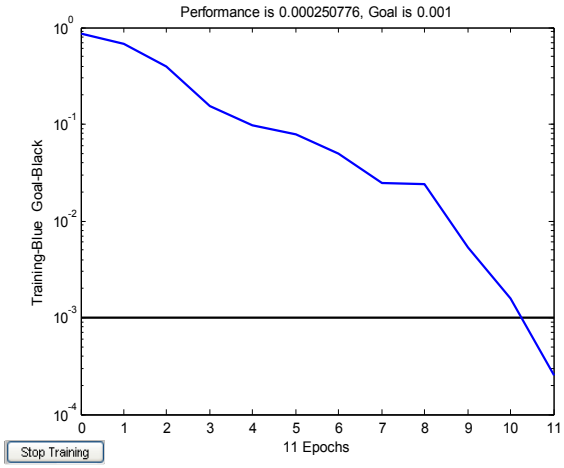

Fig.22 training steps and performance

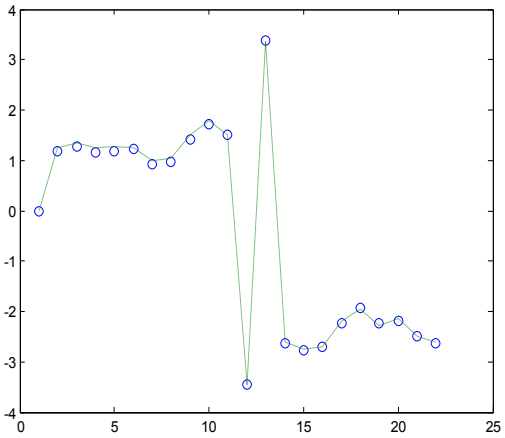

Fig.23 horizontal displacement data(Dotted line), prediction data(mark with circles)

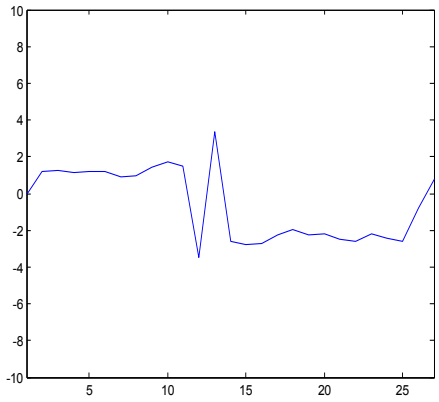

Fig.24 Elevation 139.3M measured data and 5 steps prediction curve

3.Elevation 141.3m：

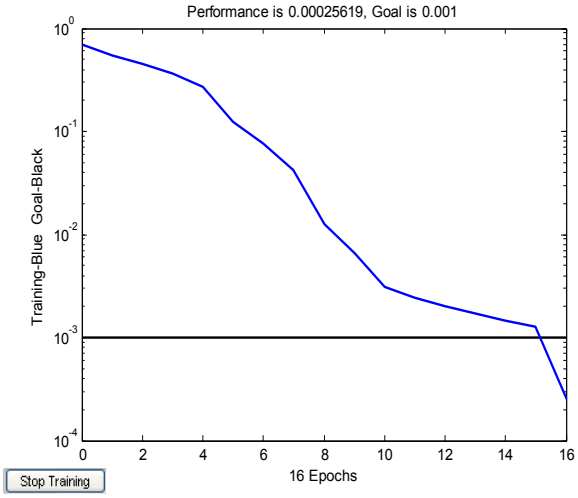

Fig.25 training steps and performance

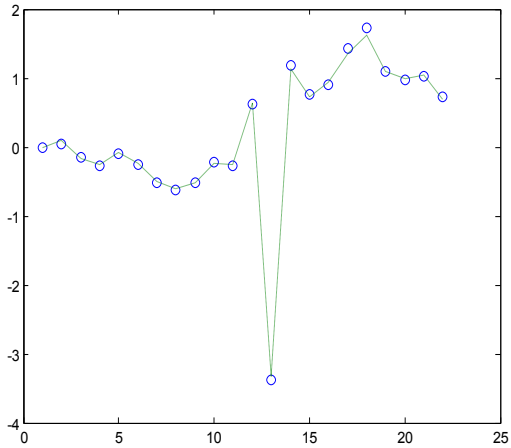

Fig.26 horizontal displacement data(Dotted line) prediction data(mark with circles)

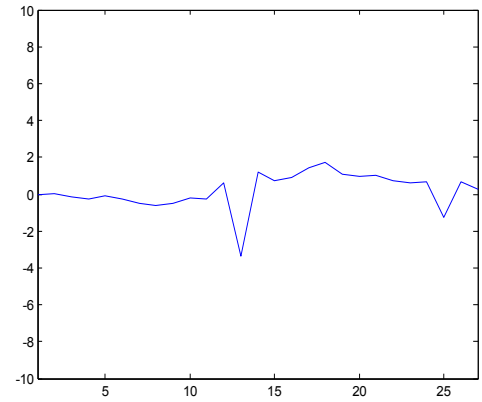

Fig.27 Elevation 141.3m measured data and 5 steps prediction curve

4.Elevation 142.8m：

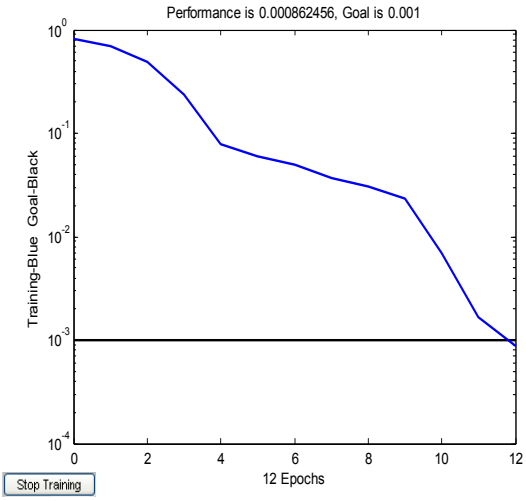

Fig.28 training steps and performance

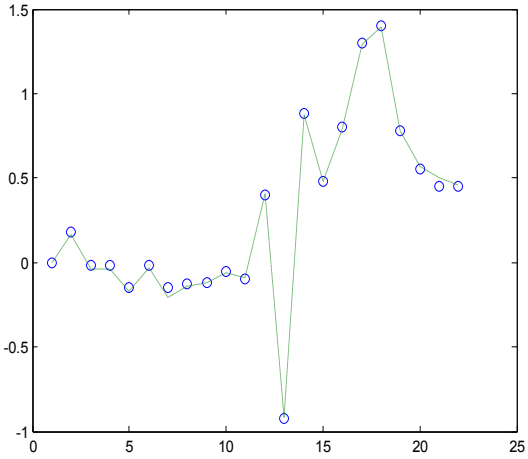

Fig.29 horizontal displacement data(Dotted line) prediction data(mark with circles)

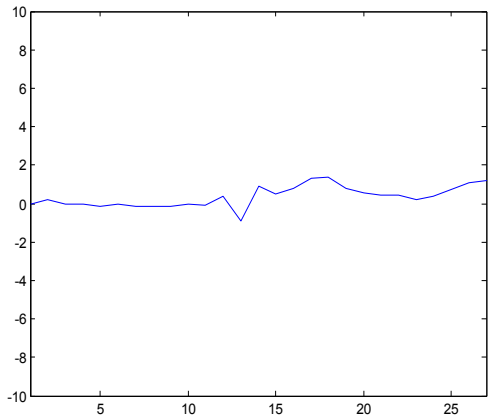

Fig.30 Elevation 142.8m measured data and 5 steps prediction curve

5.Elevation 144.3m：

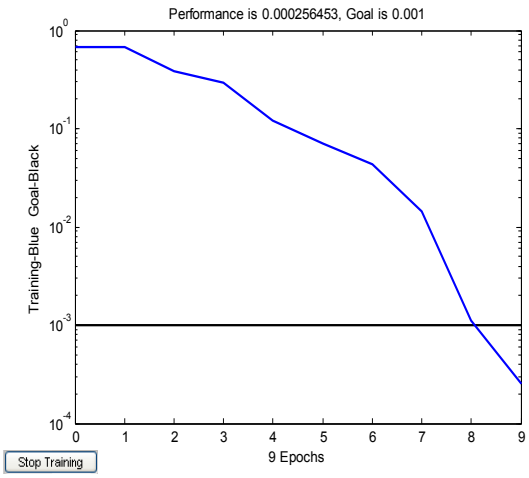

Fig.31 training steps and performance

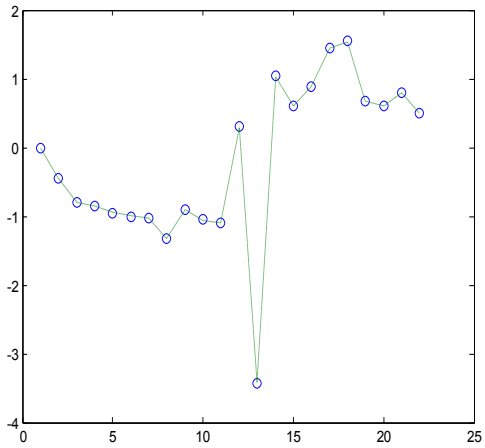

Fig.32 horizontal displacement data(Dotted line) prediction data(mark with circles)

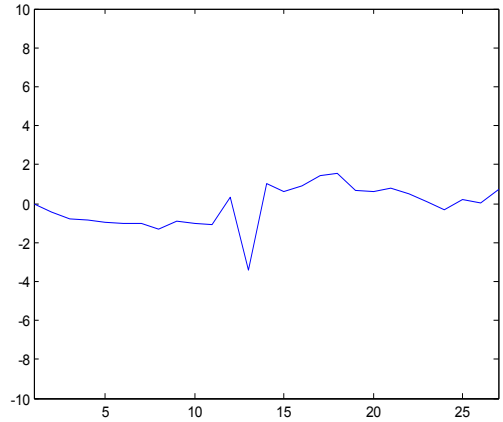

Fig.33 Elevation 144.3m measured data and 5 steps prediction curve

6.Elevation 146.3m：

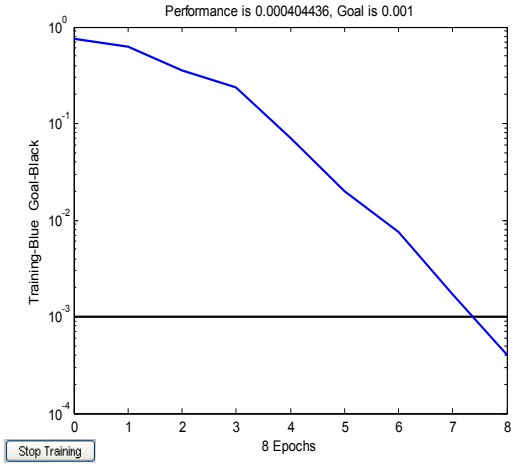

Fig.34 training steps and performance

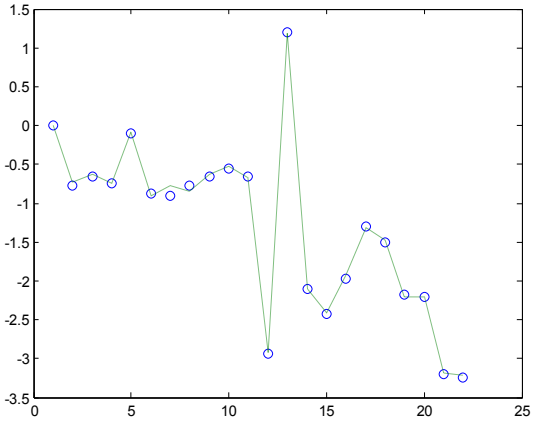

Fig.35 horizontal displacement data(Dotted line) prediction data(mark with circles)

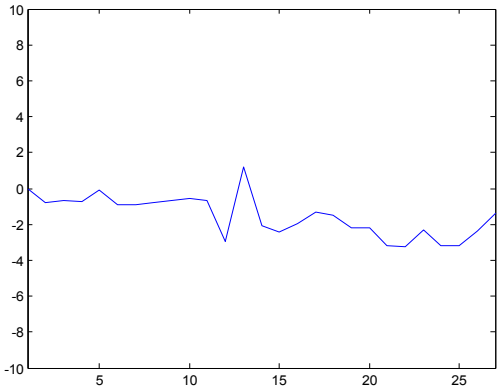

Fig.36 Elevation 146.3m measured data and 5 steps prediction curve

From TABLE 2-7 and Fig.1-36,we can see prediction data nearly match the measured data, and prediction data show Breakwater project is stable and reliable.

3. Conclusion

By the analysis of relation of Measured data---frequency and stresses1 stresses2-----we can see the different parts have strong relevance, incidence relation Consistent and reliable. TABLE 9 are correlation coefficent matrix of frequency temperature stresses1 stresses2, TABLE 10 are matrix of Covariance.

TABLE 9 correlation coefficent matrix

	frequency	temperature	stresses1	stresses2
frequency	61930.77			
temperature	24.86801	40.34717		
stresses1	780.4391	-0.01748	23.28016	
stresses2	941.9069	-0.95002	24.7977	31.05626

TABLE 10 matrix of Covariance

	frequency	temperature	stresses1	stresses2
frequency	1			
temperature	0.02161	1		
stresses1	0.650067	0.001253	1	
stresses2	0.68008	-0.02719	0.922379	1

4. References

[1] S. Tamari *, J. H. M. Wösten and J. C. Ruiz-Suárez, Nov, 1996. Testing an Artificial Neural Network for Predicting Soil Hydraulic Conductivity. Soil Science Society of America Journal Vol. 60 No. 6, p. 1732-1741

[2] Sara Casciati. (2010) Response Surface Models to Detect and Localize Distributed Cracks in a Complex Continuum. Journal of Engineering Mechanics 136:9,p.1131-1142

[3] Bin Xu, Ping Lu, Yurong Guo, and Yan Xiao. 2010. Remote Structure Parameters Estimation on NetSlab Platform Using Response Time Series. p. 2477-2486