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Errata

The publisher would like to apologize for the missing figures in the following paper published in volume 7, number 3. In the following Section 5 of this paper is reproduced.

RESPONSE PREDICTION OF STRUCTURAL SYSTEM SUBJECT TO EARTHQUAKE MOTIONS USING ARTIFICIAL NEURAL NETWORK

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5. NUMERICAL RESULTS AND DISCUSSIONS

For the present study two Indian earthquakes viz. the Chamoli Earthquake (max. ground acceleration=0.16885 m/sec/sec) at Barkot in NE (north–east) direction shown in Figure 3(a) and the Uttarkashi earthquake (maximum ground acceleration=0.931 m/sec/sec) at Barkot in NE (north–east) direction as given in Figure 3(b) have been considered for training. First the ground acceleration of Chamoli earthquake was used to compute the response for single storey structure using the usual procedure. The obtained responses and the ground acceleration are trained by the said ANN model for a structural system with frequency parameter ω=0.68981 and damping=1.58033. This training was done for the total time range 0 to 14.92 seconds (748 points, earthquake period) taking the continuous activation function with accuracy 0.0005. When the network is trained then by direct use of the converged weight matrix gives the structural response. Accordingly a plot of 100% response comparison between neural network results and desired response for Chamoli earthquake at barkot (NE) is shown in Figure 3(c). After training ground acceleration and response data for Chamoli earthquake for various nodes in the hidden layer it was confirmed that 10 nodes are sufficient for the prediction. So, the weights corresponding to 10 hidden nodes are stored and they are used to predict responses for various intensity earthquakes. It is worth mentioning here that the response for any other earthquake can be predicted using the converged weights after the training with Chamoli earthquake (or any particular earthquake). Here, the response for Uttarkashi earthquake at Barkot in NE direction is predicted using the trained network by Chamoli earthquake (at the same place) for the

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considered structure. The Uttarkashi earthquake occurred on October 20, 1991 is more stronger (maximum response=0.9317 m/sec/sec) than the Chamoli earthquake (maximum response=0.16885 m/sec/sec), which occurred on March 29, 1999. Here, first the network is trained for a suitable high percentage of Chamoli earthquake and then the converged weights from this training is used to predict the response for Uttarkashi earthquake at Barkot (NE), Tehri (in NE directions) and for the Chamoli Earthquake at Barkot (NW). The response comparisons between the neural (using the trained weights from Chamoli earthquake) and desired of Uttarkashi earthquake at Barkot (NE) and Tehri (NE) are shown in Figures. 4(a) and 4(b) respectively. Similarly, the response comparison between the neural and desired of Chamoli earthquake at Tehri (NW) is also shown in Figure 4(c).

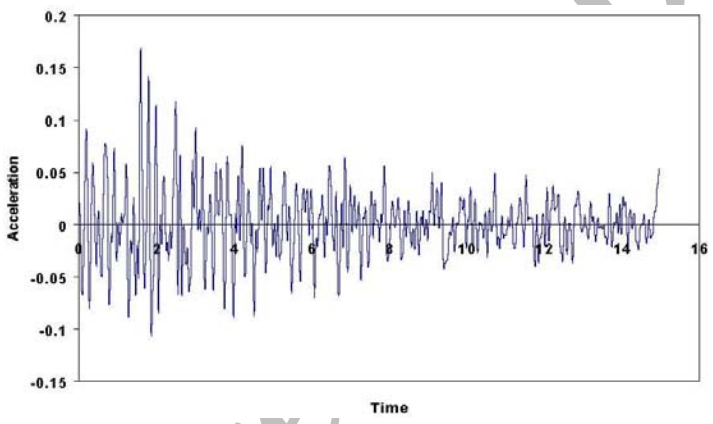

Figure 3(a). Chamoli earthquake recorded at Barkot (NE direction)
peak acceleration = 0.16885m/sec/sec

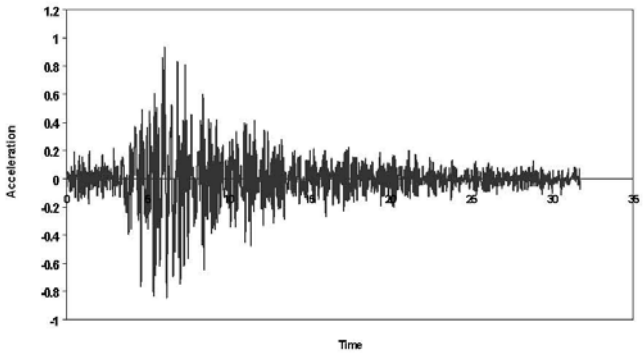

Figure 3(b). Uttarkashi earthquake recorded at Barkot (NE direction)
peak acceleration = 0.9317 m/sec/sec

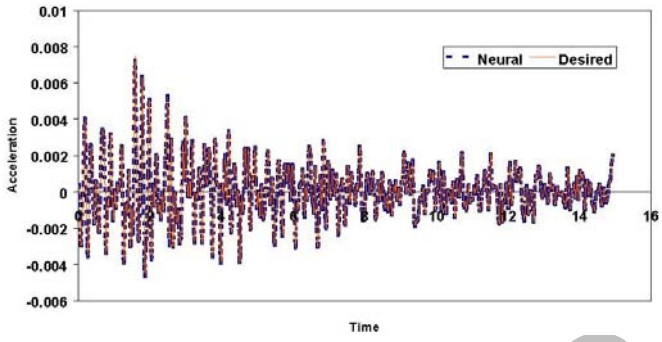

Figure 3(c). 100% Response Comparison between Neural and Desired for Chamoli Earthquake at Barkot (NE)

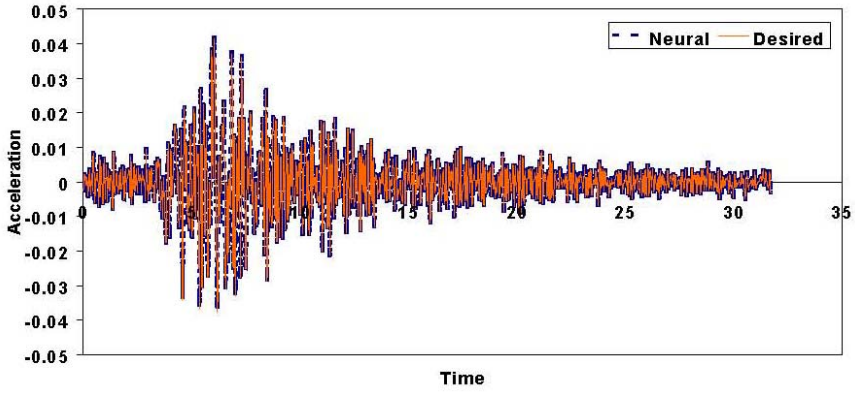

Figure 4(a). Response Comparison between Neural and Desired for Uttarkashi Earthquake at Tehri (NE) Using weights of 650% of Chamoli Earthquake at Barkot (NE)

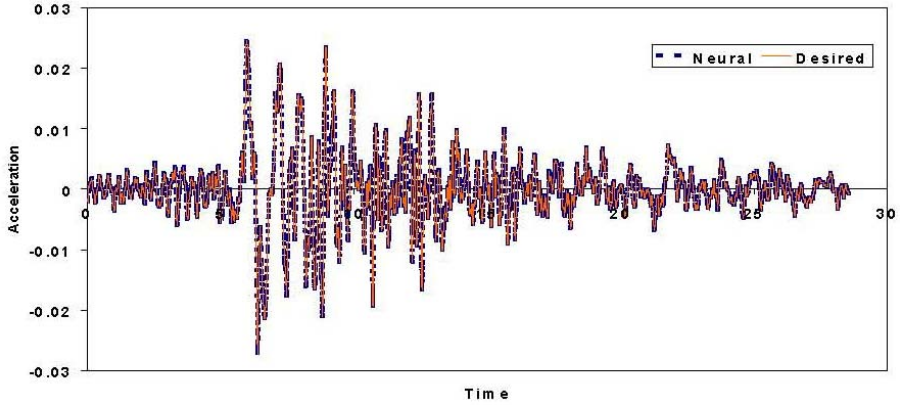

Figure 4(b). Response Comparison between Neural and Desired for Uttarkashi Earthquake at Tehri (NE) Using weights of 650% of Chamoli Earthquake at Barkot (NE)

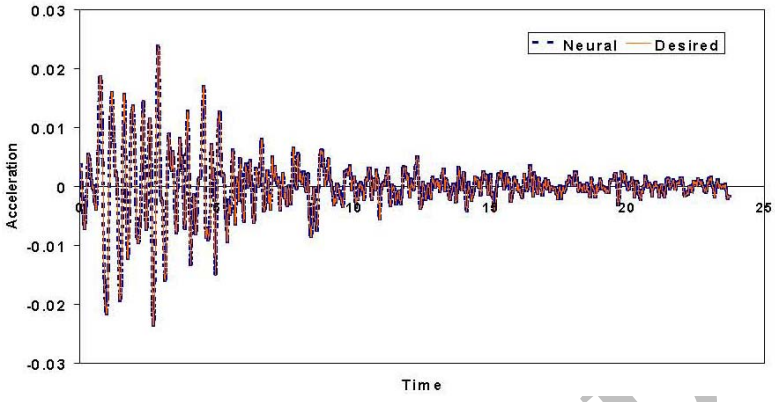

Figure 4(c). Response Comparison between Neural and Desired for Uttarkashi Earthquake at Tehri (NW) Using weights of 650% of Chamoli Earthquake at Barkot (NE)

Next, the Uttarkashi earthquake at Barkot (NE) ground acceleration and the corresponding response of the structure are trained for another example with the same frequency parameter ω=0.68981 but with different damping=0.05. The weights obtained after training Uttarkashi earthquake at Barkot (NE) is used to predict the response for Chamoli earthquake at Barkot (NW), Tehri (NE) and for the Uttarkashi earthquake at Tehri (in NW direction). The response comparisons between the neural and desired of Chamoli earthquake at Barkot (NE) and Tehri (NE) are shown in Figures 5(a) and 5(b) respectively. Similarly, the response comparisons between the neural and desired of Uttarkashi earthquake at Tehri (NW) is shown in Figure 5(c).

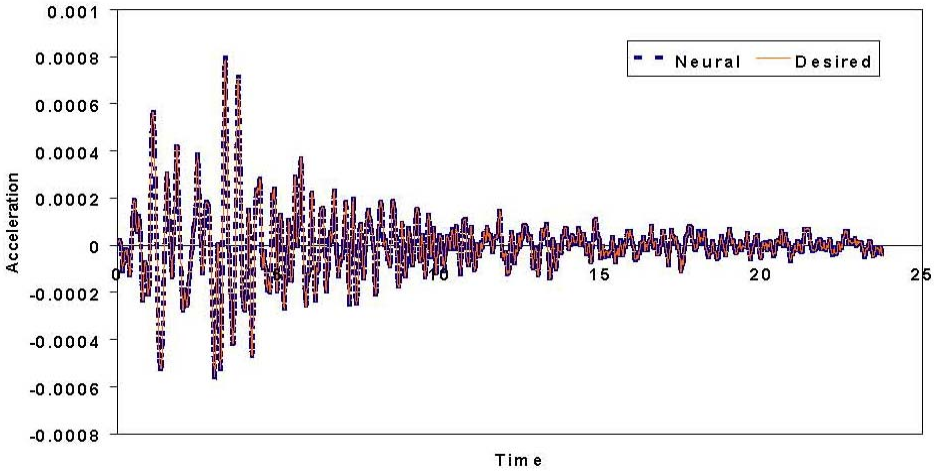

Figure 5(a). Response Comparison between Neural and Desired for Chamoli Earthquake at Barkot (NE) Using Weights of Uttarkashi Earthquake at Barkot (NE)

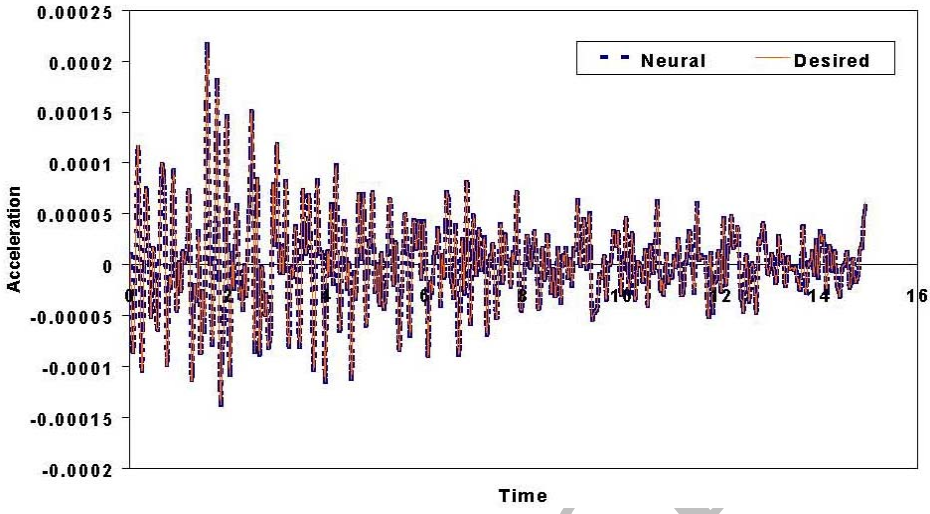

Figure 5(b). Response Comparison between Neural and Desired for Chamoli Earthquake at Barkot (NE) Using Weights of Uttarkashi Earthquake at Barkot (NE)

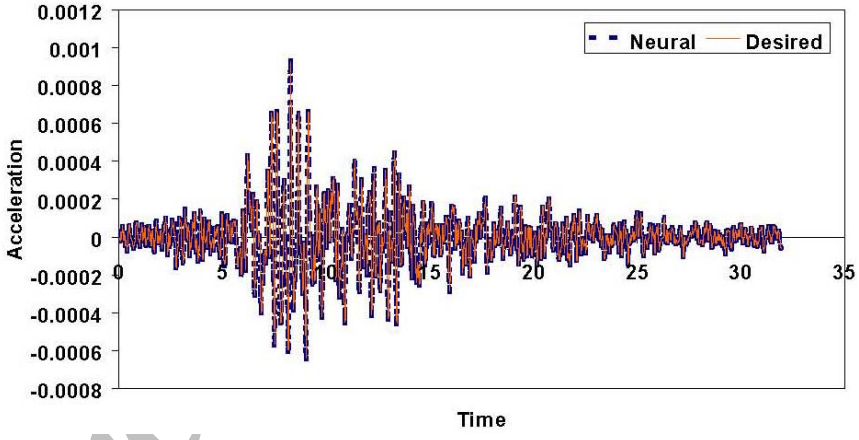

Figure 5(c). Response Comparison between Neural and Desired for Chamoli Earthquake at Barkot (NW) Using Weights of Uttarkashi Earthquake at Barkot (NE)

Here, a part of the ground acceleration is also used for the training and it will be shown that the present ANN model can predict the whole period of the response using the trained ANN by the part of the data. So, the ground acceleration and response data with Chamoli earthquake at Barkot (NE) is trained without damping for an example with the time range 0 to 10.96 sec (550 data points) and its neural and desired response comparison is shown in Figure 6(a). Its weights are stored to find the response for the time range 0 to 14.92 seconds (748 data points, i.e. whole period). The 100% response comparison between neural and desired for ω=0.05 (maximum response=0.168849 m/sec/sec) from the time range 0 to 14.92 seconds (748 data points) is incorporated in Figure 6(b). These are obtained from the weights of the trained data for the time range 0 to 10.96 seconds (550 data points).

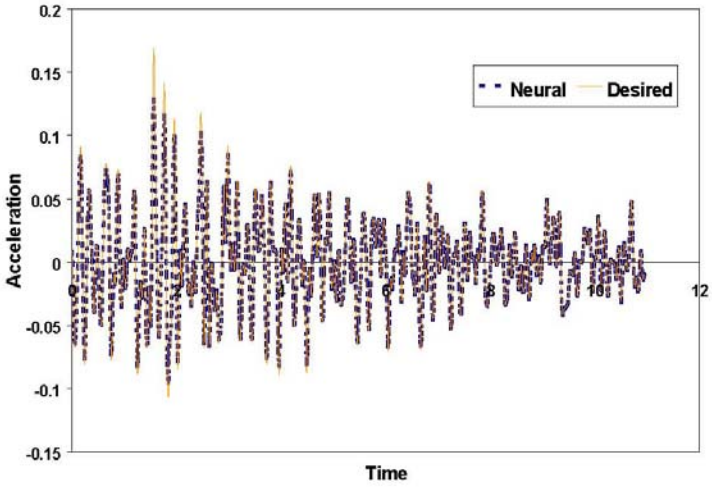

Figure 6(a). Response Comparison Between Neural and Desired (550 points) for Chamoli Earthquake at Barkot (NE)

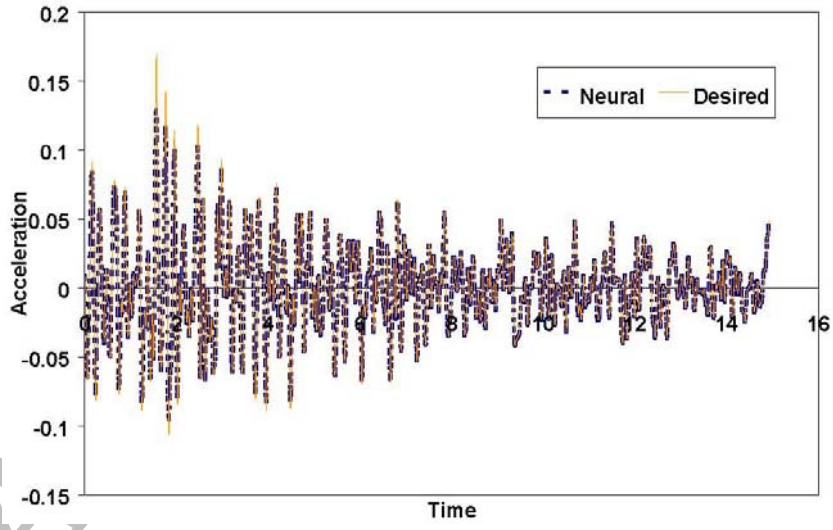

Figure 6(b). Response Comparison Between Neural and Desired (748 points) for Chamoli Earthquake at Barkot (NE) from weights obtained after training from 550 points

A better representation of the results may be seen from Figure 7(a), which shows the maximum response comparison subject to Chamoli earthquake at Barkot, Tehri and Uttarkashi (NE) between neural and desired results. Similar results for Chamoli earthquake at Barkot, Tehri and Uttarkashi (NW) are given in Figure 7(b). The phase plane plots of neural and desired of Chamoli earthquake at Barkot in NE direction are given in Figures. 8(a) and 8(b). Using the weights of Chamoli training, the phase plane plots of neural and

desired of Uttarkashi earthquake at Barkot (NE) are given in Figures 8(c) and 8(d). The phase plane plots given in Figures 8(a) to 8(d) very well depicts the efficacy of the neural network which shows the good comparisons between the neural and desired results.

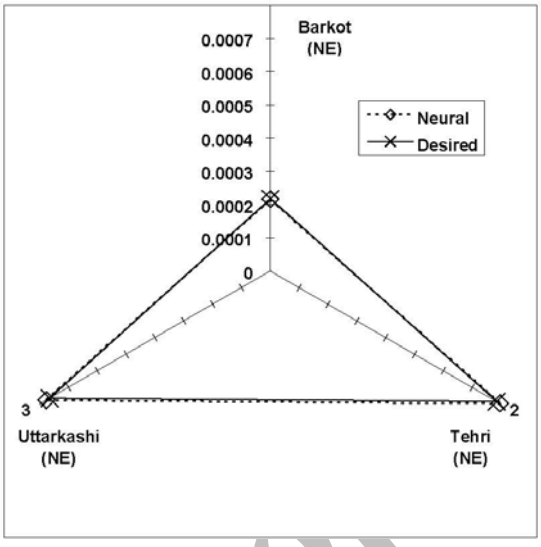

Figure 7(a). Comparison between neural and desired of Maximum Structural Response for Chamoli Earthquake at Barkot, Tehri and Uttarkashi in

North-East Direction

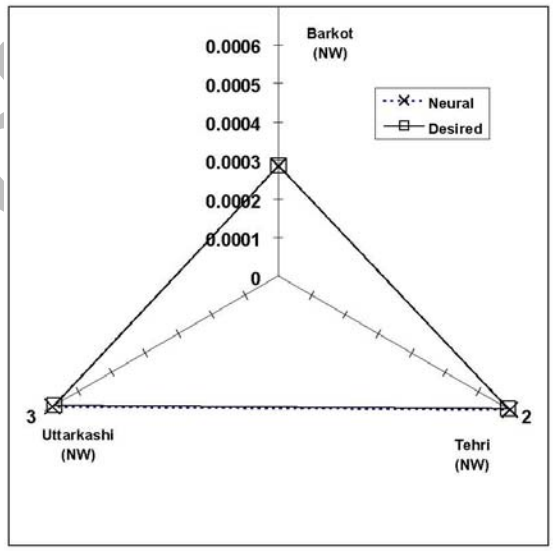

Figure 7(b). Comparison Between Neural and Desired of Maximum Structural Response for Chamoli Earthquake at Barkot, Tehri and Uttarkashi in

North-West Direction

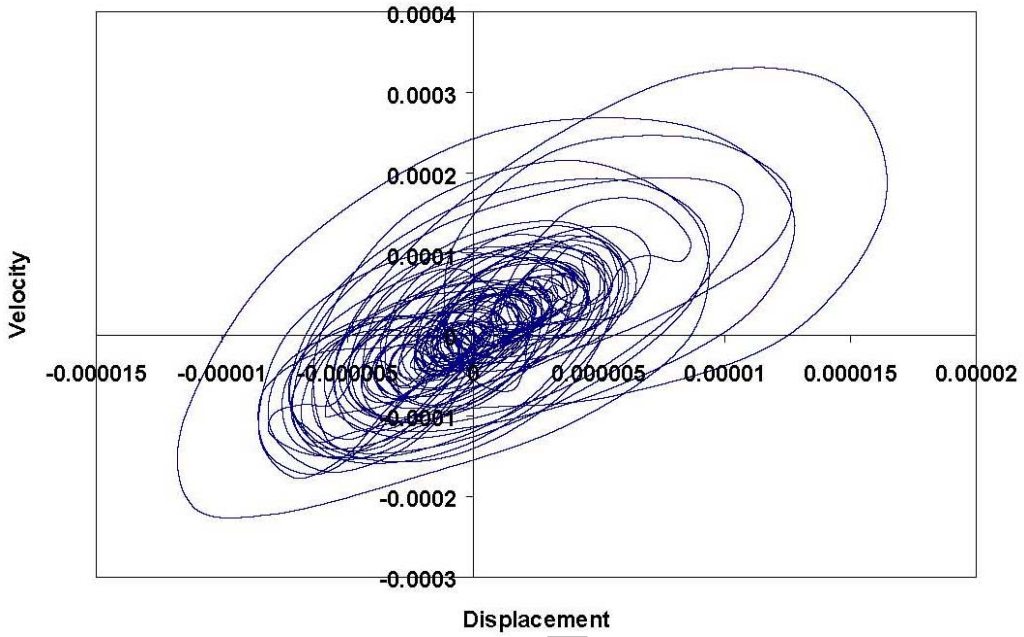

Figure 8(a). Phase Plot of Neural results for Chamoli Earthquake at Barkot (NE)

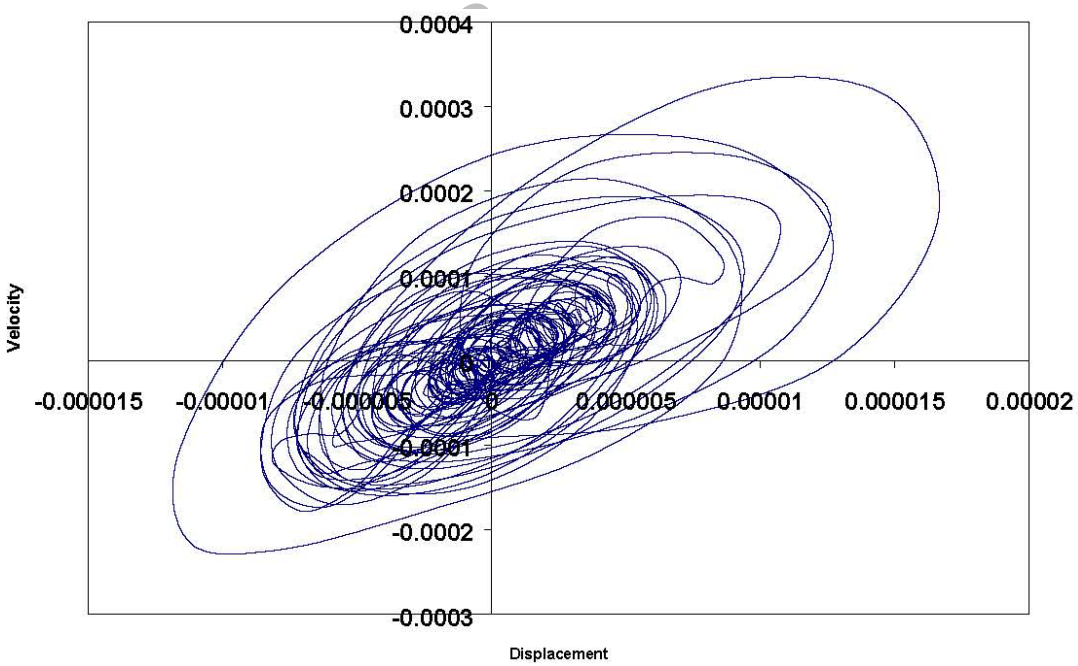

Figure 8(b). Desired Phase Plot for Chamoli Earthquake at Barkot (NE)

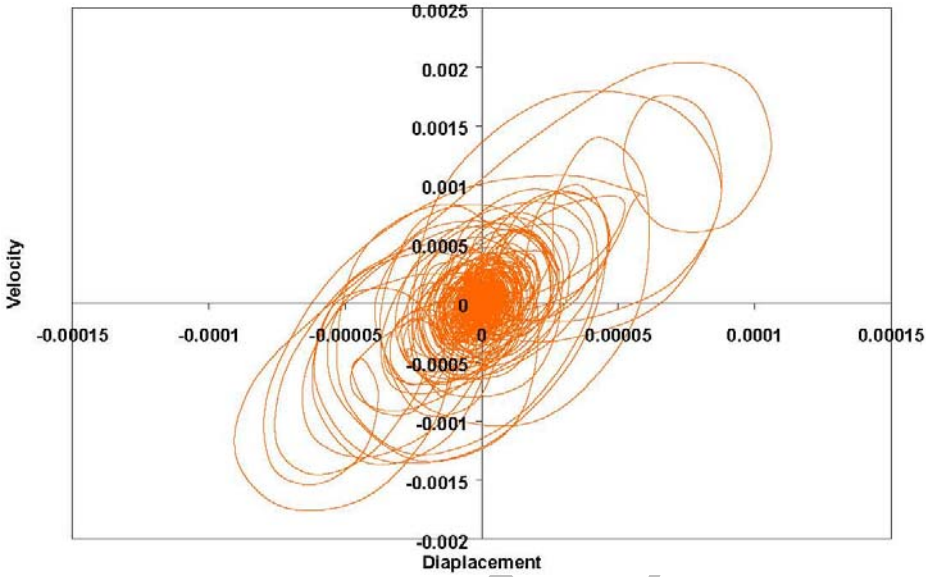

Figure 8(c). Phase Plot of Neural for Uttarkashi Earthquake at Barkot (NE) using weights of trained Chamoli Earthquake

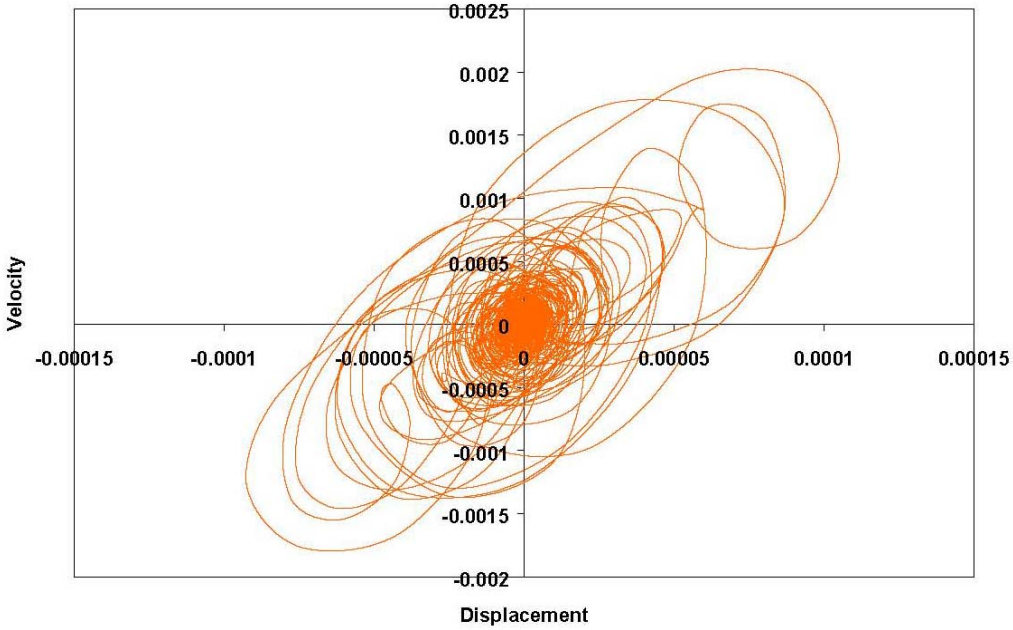

Figure 8(d). Desired Phase Plot for Uttarkashi Earthquake at Barkot (NE)