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Artificial neural network Approach for Ductility Computation of Flexural RC Members

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Abstract

Ductility of structure is an essential property of structures responding inelastically during severs shaking, such as earthquake. As a result, the inertial forces imposed to the structures can be decreased. Several forms of ductility are often considered, these include curvature and displacement ductility. The calculation of the accurate values of ductility of members is usually complicated and therefore a direct and accurate approach to obtain such value is necessary needed particularly in seismic regions. In this paper, one method is considered to calculate the flexural curvature ductility ratio of reinforced concrete (RC) sections. In this approach to calculate curvature ductility factor of RC beams was presented by using artificial neural network (ANN).To investigate the performance and accuracy of the ANN method, fifteen high strength concrete (HSC) beams were casted and tested under bending and also the available results of thirty eight beams were selected from the literature. Based on the obtained experimental results a comparison was made experimental results and artificial neural network, and it was shown that a good agreement is available.

Keywords: Concrete RC beams, Ductility, Experimental (HSC) tests, Artificial neural network

1. INTRODUCTION

In seismic areas, ductility is an important factor in design of concrete members under flexure, it is due to the increase in capacity of plastic displacement. As a result, the inertial forces imposed to the structures can be decreased [1]. The effective factors on ductility are; concrete compression strength f'_c, the percentage of tension and compression steel, ρ and ρ', the amount of stirrups confinement for concrete ρ_c, the stirrups spacing, brittle effect of concrete strength, yield stress of longitudinal bars f_y and the effect of width to the depth of the section b/h [2,3,4].
Beams ductility can be presented based on behaviour of members section or the entire members' behaviour. Prevalent criterion of beams ductility calculation according to entire members behaviour are the ratio of ultimate displacement to yield displacement ($\mu=\Delta_u/\Delta_y$), ratio of ultimate rotation to yield rotation ($\mu=\theta_u/\theta_y$) and the value of structure absorbed energy. Perhaps the most simple and general definition for section ductility of members is defined, ratio of curvatures at ultimate load to curvatures at yield load ($\mu=\phi_u/\phi_y$). The entire members' behaviour reveal the actual behaviour of the structure but calculation of member section behaviour is simpler. However, the experimental results show that the difference between curvature and displacement value of ductility are quite small [5, 6] and hence, the curvature ductility is used generally to investigate the member behaviour. The effect of concrete confinement with ties on flexure ductility was studied by many researchers [7, 8, 9, 10, 11]. But in this research, ductility is calculated based on actual characteristics of a RC flexural section (Experimental strain-stress curves for confined and unconfined concrete) and act as a separator proposed curves, which divide the zone into; effective confined concrete core, unconfined concrete core and unconfined concrete cover. In this method, the compression zone of rectangular section under bending is assumed to act as a separator proposed curves, which divide the zones into; effective confined concrete core, unconfined concrete core and unconfined concrete cover. The method is also based on actual characteristics of a RC flexural section by considering almost all effective ductility parameters such as available experimental concrete compression diagrams.
The calculations of the accurate values of curvature ductility of members are usually complicated particularly in confined concrete beams and therefore by the use of simplified formula can be much easy [12]. Lee and Pan presented an algorithm and simplified formulas for estimating the relationship between only the tension reinforcement and ductility of reinforced concrete beams. They considered the effects of concrete confinement and spilling of the concrete cover. Calculating of ductility based on Lee and Pan's method is time consuming and difficult.