NEURAL NETWORK MODELS FOR COMPOSITE BEAMS AND FRAMES CONSIDERING CRACKING AND TIME-EFFECTS

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CERTIFICATE

This is to certify that the thesis entitled, "**NEURAL NETWORK MODELS FOR COMPOSITE BEAMS AND FRAMES CONSIDERING CRACKING AND TIME-EFFECTS** " being submitted by **Umesh Pendharkar** to the Indian Institute of Technology, Delhi for the award of the degree of **Doctor of Philosophy** is a bonafide record of research work carried out by him under my supervision and guidance. The thesis work, in my opinion, has reached the requisite standard fulfilling the requirement for the degree of **Doctor of Philosophy**.

The results contained in this thesis have not been submitted, in part or full, to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

Steel and concrete composite construction has been widely used in building construction. In composite construction high strength of concrete in compression complements high strength of steel in tension. The cracking of concrete in continuous composite beams and frames in hogging moment regions near supports, results in moment redistribution along the length and change in deflections of beams. Time-effects in concrete (creep and shrinkage) further lead to the progressive cracking of concrete slab of composite beams and thereby to moment redistribution and change in deflections of beams. The appropriate prediction of instantaneous as well as time-dependent inelastic design quantities of composite beams and composite building frames at service load, considering the cracking of concrete and time-effects is therefore important.

Generally, the methods available for the analysis of composite frames and bridges are either too cumbersome or do not take into account all the aspects. A hybrid analytical-numerical procedure has been developed recently at IITD, for the instantaneous and time-dependent analysis of composite building frames at service load applicable for uniformly distributed loading. Since, any loading can be represented by a set of concentrated loads, so, as a step towards consideration of practical loading, the procedure is extended for a concentrated load on composite beams. The results have been compared with the results from finite element software ABAQUS.

No simple procedure exists to estimate sufficiently accurately, inelastic design quantities at service loads, for use in everyday design. Here a neural network based methodology has been presented to predict inelastic design quantities (inelastic moments, mid-span inelastic deflections) from elastic design quantities (elastic moments and mid-span elastic deflections). The elastic design quantities can be

obtained from any of the readily available software. The proposed procedure predicts inelastic design quantities from elastic design quantities with practically no additional computational efforts than that required for predicting elastic design quantities, resulting in drastic reduction in computational effort. The proposed procedure is also simple in application.

Four neural network models for estimating inelastic moments and five neural network models for estimating mid-span inelastic deflections by considering three types of continuous composite beams - two span, three span and seven span; have been developed. The neural network models developed for seven span beams can be used for beams having any number of spans more than three. Similarly, two neural network models each, for estimating inelastic moments and mid-span inelastic deflections, have been developed for low rise frames and high rise frames, respectively. These models can be used for frames with any number of bays and stories.

The huge training data sets, required for development of neural network models, both for beams and frames, have been generated using the hybrid procedure. Uniformly distributed load has been considered in the development of the models. Their applicability for a concentrated load has been demonstrated.

The networks have been validated by comparison with results from the hybrid procedure.

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