STRUCTURAL CONNECTIVITY OF TWO-DIMENSIONAL ASSEMBLIES

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June, 2020

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The Research Thesis was submitted in partial fulfilment of the requirements for the Degree of Master of Science of Engineering

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June, 2020

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Prof. W. P. S. Dias

ABSTRACT

STRUCTURAL CONNECTIVITY OF TWO-DIMENSIONAL ASSEMBLIES

The characterization of structures based only on their geometrical configuration and independent of loading is a novel approach for evaluating and designing structures to be robust against accidental damage. The concept of ‘structural connectivity’ is introduced to assess the connectivity of the structure at multiple hierarchical levels. An adaptation of the Bristol approach is tentatively suggested as providing the most appropriate measure for structural connectivity. Three other measures, conventional connectivity indices in Graph theory, Newman’s approach based on Network theory and Route structure analysis (originally developed to analyse road networks) are used to compare the results obtained from the Bristol approach. Three trusses of the same outer shape but differing in geometric configuration were analysed using all four methods to find the best connected truss. The configurations analysed are Fractal, Warren and Fan-type trusses. Axial rigidity of the chord members were increased to check its effects on structural connectivity. The different measures gave different results for the same structure, though there is some degree of consistency. Graph theory and Unweighted Newman’s approach suggest that the Fractal truss has the most well-connected configuration, whereas the Bristol approach favours the Fan-Type type truss. Weighted Newman analysis and Route structure analysis indicate that Warren truss to be the most wellformed configuration. All three methods indicate that truss ends and central regions of chord members are the least connected areas. All weighted analysis methods show that increasing the chord member stiffness benefits structural connectivity of all truss forms. Separately, a frame (4 bays x 5 floors) with different column elements removed was also analysed, in order to determine the column removal that would result in the least degree of frame connectivity. Though different methods indicated different column removals to cause the highest loss in structural connectivity, all methods agree that the middle column removals causes higher loss in connectivity than side column removal in the corresponding floor. An idealised “A-Level” road network in Sri Lanka was analysed as proof that concept of structural connectivity can be applied to assemblies other than structures.

Key Words:

structural connectivity, hierarchical clustering, disproportional collapse, network connectivity, road network

DEDICATION

I would like to dedicate this thesis to my family, friends and my research supervisor, without whom this research would not be.

ACKNOWLEDGEMENT

I would like to pay gratitude to everyone who gave support during the research study as it would have never succeeded without them.

I would like to express my profound gratitude and warm regards to the supervisor of this research, Prof. W.P.S. Dias, Senior Professor, Department of Civil Engineering, University of Moratuwa, for proving me a research opportunity, guiding me with continuous supervision and sharing his broad knowledge and time for my research project. I'm indebted to him for the support he has given me throughout my extended research duration and in producing this thesis.

I would also like to thank Dr. H.M.Y.C. Mallikarachchi, Prof. R.U. Halwatura and Dr. J.C.P.H Gamage for their valuable input during the research progress evaluations. I would like to specially acknowledge Eng. V. Vibujithan for helping in the initial form of the MATLAB code.

I appreciate my employers, during the course of research, in providing necessary leaves to follow the course module as well as to prepare for the progress reviews.

I am truly grateful for the support given by my family and friends during this research. Their motivation is one of the major factors in succeeding in this research.

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LIST OF ABBREVIATIONS

Abbreviation	Description
GMR	Ground floor- Middle column removal
GSR	Ground floor- Side column removal
JS	Joint stiffness
MMR	Middle floor- Middle column removal
MSR	Middle floor- Side column removal
RSA	Route Structure Analysis
TMR	Top floor- Middle column removal
TSR	Top floor- Side column removal
WF	Wellformedness