THESIS INFORMATION

Title: **DEVELOPMENT OF MOVING ELEMENT METHOD FOR SOME DYNAMIC PROBLEMS OF STRUCTURES**

Major: **Civil and Industrial Engineering**

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PhD student: **Cao Tan Ngoc Than**

Advisors: **1. Associate Prof. Dr. Luong Van Hai**

2. Associate Prof. Dr. Nguyen Trong Phuoc

University: **University of Technology, Vietnam National University – Ho Chi Minh City**

Contributions of this thesis

The overarching goal of this thesis is to develop the Moving Element Method (MEM) for analyzing the dynamic responses of some beam and plate structures subjected to moving loads. The benefits of the MEM compared with the Finite Element Method (FEM) are as follows: firstly, the moving elements in the MEM are formulated in a coordinate system moving at the velocity of the moving load, instead of a fixed coordinate system as in the FEM. Thus, the position of the moving load becomes fixed at a particular node in the moving element mesh and the advantage is that the need to keep track of the moving load position can be avoid. Secondly, in dealing with the problems related to the load moves on the structures which are assumed infinitely long (such as the rail beam, pavement of highway, the runway...), the FEM encounters difficulty when the moving load approaches the boundary end of the finite domain and travels beyond the boundary. However, the moving load will never reach the boundary end of the numerical model in the MEM since the elements move along with it and this difficulty of the FEM can be overcome. Thirdly, the structure can be discretized with non-uniform mesh and it is convenient for solving the problems in which the structure is subjected to multiple moving loads with non-uniform spacing. Fourthly, the number of elements used in the MEM model is independent of the distance traversed by the load in the time duration considered. Hence, the MEM requires comparatively lesser elements and is more computationally efficient than the FEM does in general. Herein, the following are the main research contributions of this thesis.

- For the beam structures subjected to moving load: the moving element method has been developed successfully for the dynamic analysis of high-speed train using the full 3D high-speed train-track model in this thesis. This method is developed for the model of two rails subjected to a moving train with the full 3D model. By using the proposed method, the effects of various parameters on the dynamic response of the high-speed train are investigated. The main difference in this section is that the dynamic responses of the high-speed train have been examined more detailed by using the proposed 3D high-speed train-track model in this thesis. It is noted that these responses could not be investigated by using the 1D high-speed train-track model in the previous studies.

- For the plate structures subjected to moving load: the moving element method has been also developed successfully for the dynamic analyses of some plate structures resting on a viscoelastic Pasternak foundation subjected to moving loads. The plate structures mentioned in the thesis are the Mindlin plate, the composite plate and the functionally graded plate, in which the dynamic responses of plates are investigated by using the proposed moving plate elements in the thesis. To the best of our knowledge, the studies on the development of the moving element method for the dynamic analysis of the Mindlin plate, the composite plate and the functionally graded plate had not been done. In addition, for the dynamic analysis of multi-layer plates subjected to moving loads, the Multi-Layer Moving Plate Method (MMPM) has been developed for solving this problem. The prominent point is that the simutaneous responses of the multi-layer plates have been examined by using the proposed Multi-Layer Moving Plate Method, but they had not been done in previous studies yet. The detailed formulas, the algorithm and the numerical examples are presented. The effects of most important physical parameters on the dynamic responses of the plates are investigated clearly and the accuracy of this method has been also verified.

Advisors	**PhD student**
Associate Prof. Dr. Luong Van Hai	Cao Tan Ngoc Than
Associate Prof. Dr. Nguyen Trong Phuoc	